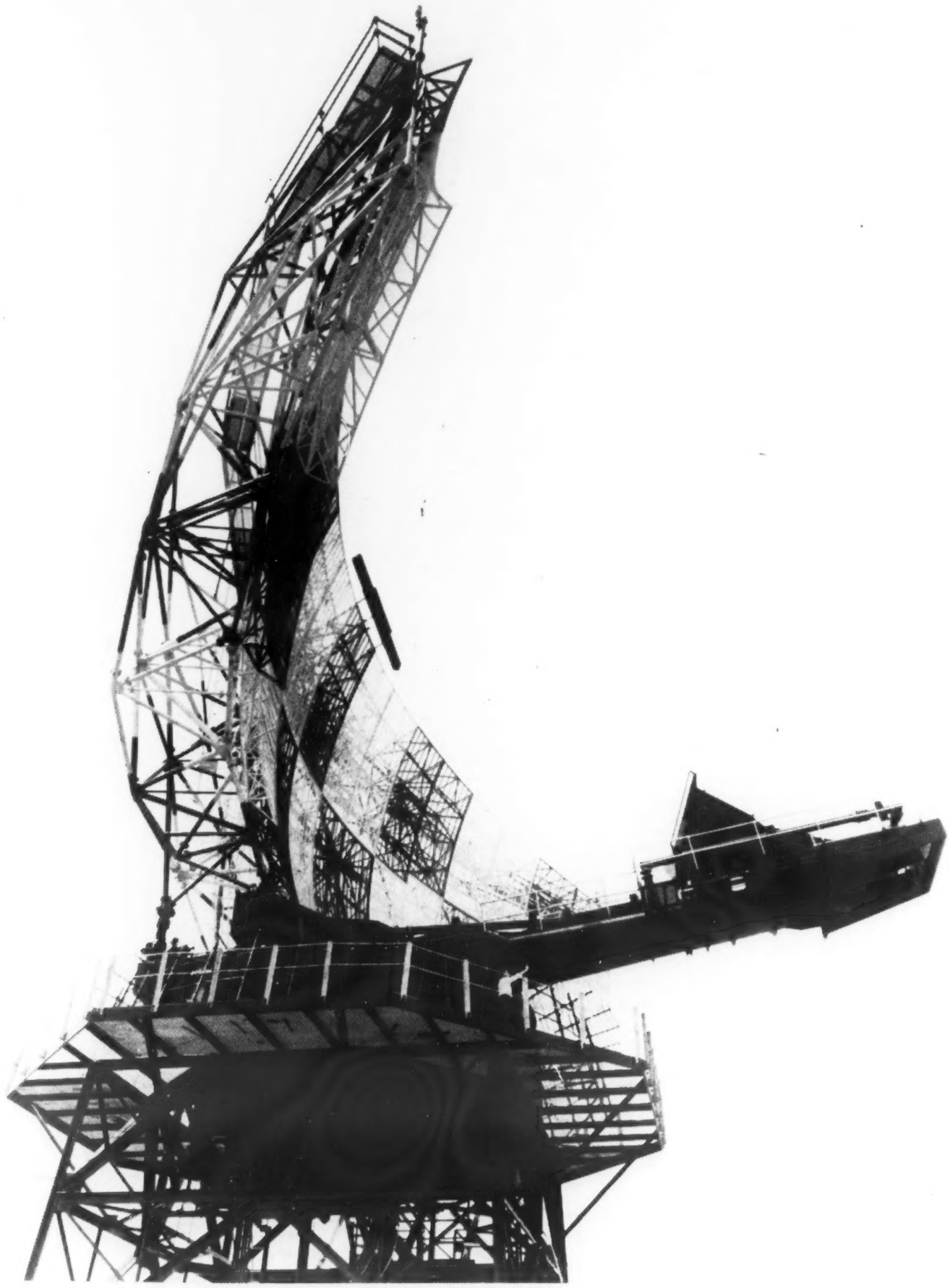
SIGNAL

February 1960



AN/FPS-24 SEARCH RADAR

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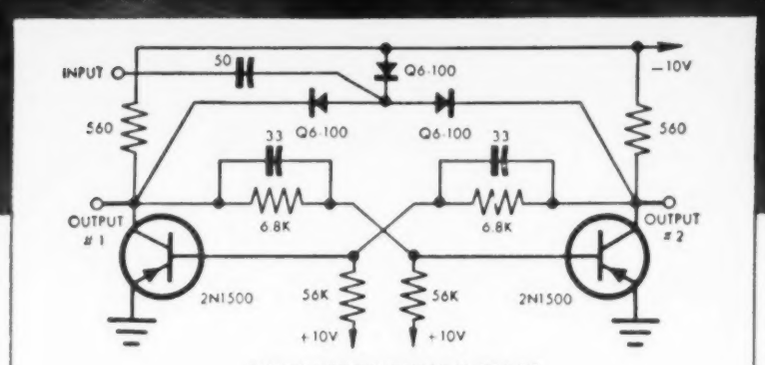

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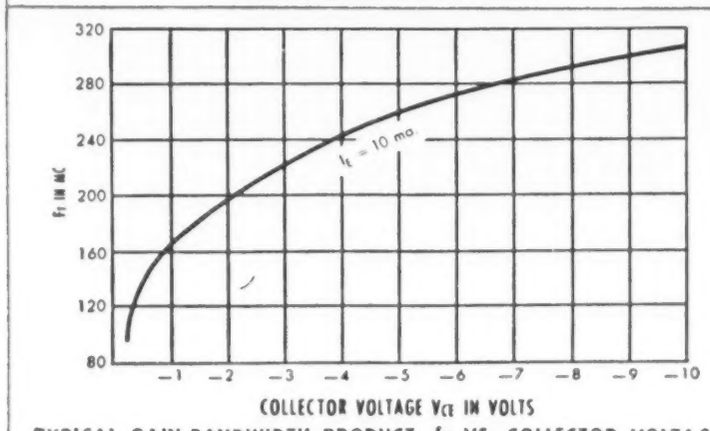

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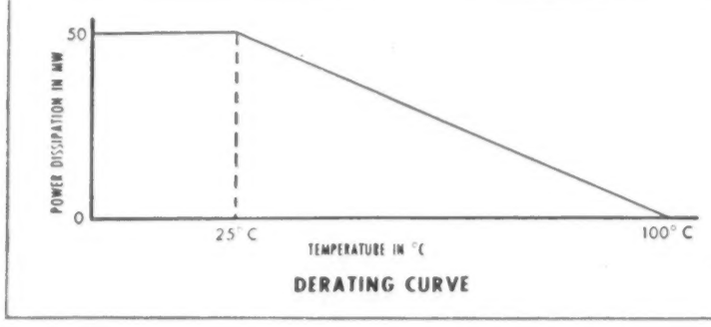

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FOR "SCIENTIFIC KNOWLEDGE AND ABLE LEADERSHIP" On October 5, 1959, the Army's Distinguished Civilian Service Award was presented to Dr. James W. McRae, Vice President of the American Telephone and Telegraph Company.

The award was given for his aid in directing the creation of a family of small, tactical nuclear weapons while he was president of Sandia Corporation—a non-profit Western Electric subsidiary under contract to the Atomic Energy Commission.

Dr. McRae is presently A.T.&T.'s co-ordinator of defense activities.

The citation was read by Lt. Gen. Arthur G. Trudeau, Chief of Army Research and Development, and said in part: "His scientific knowledge and able leadership have contributed materially to the development for the Army of small, tactical nuclear weapons, thereby significantly increasing the Army's capability to carry out its combat mission."

Bell System people everywhere are proud of Dr. McRae's recognition. And they are proud, also, that the skills and experience they apply in telephone work are also useful in the nation's defense.

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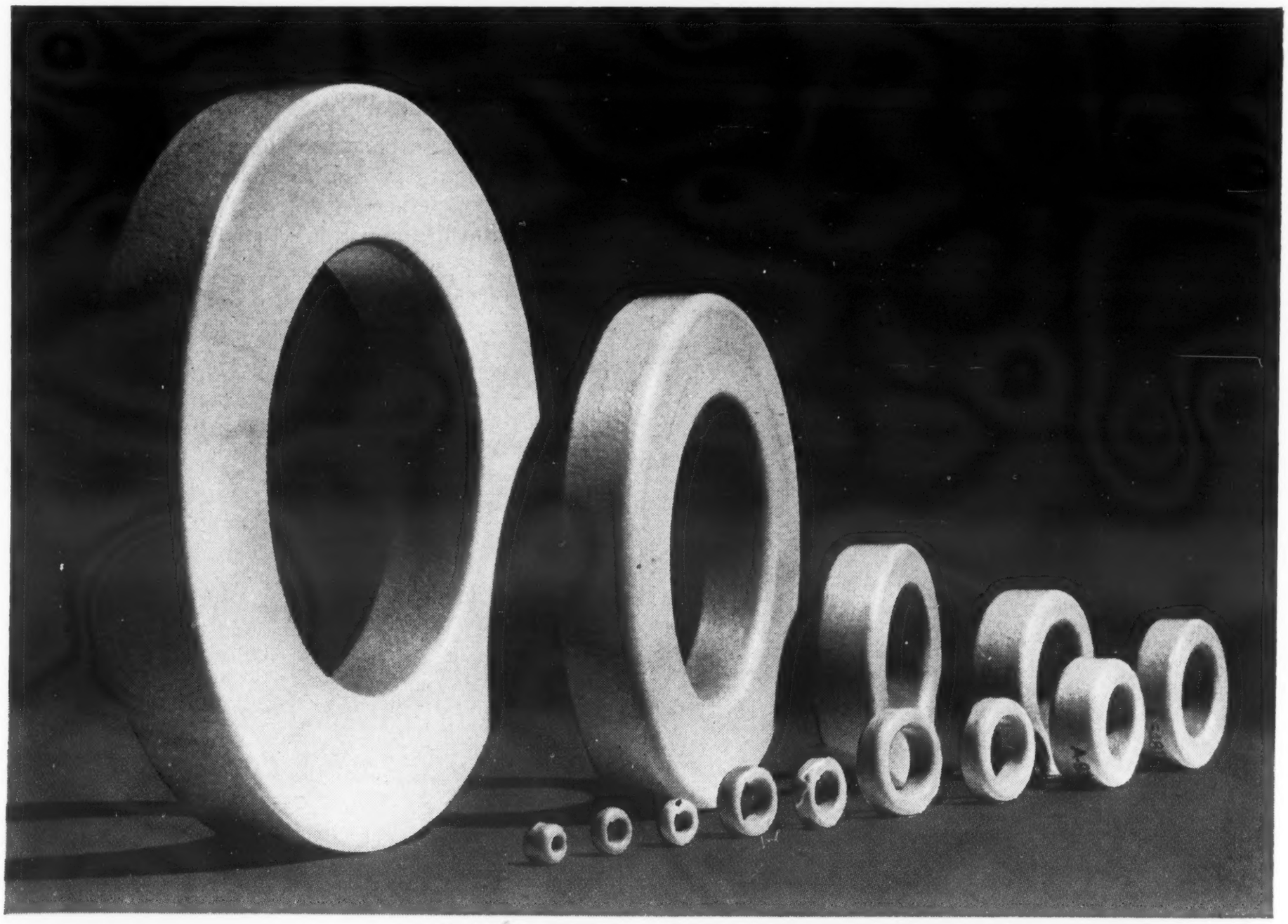

SIGNAL

Communications-Electronics-Photography

Journal of the Armed Forces Communications and Electronics Association

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The giant reflector for G.E.'s AN/FPS-24 Search Radar measures 120 ft. by 36 ft. and weighs 30 tons. See story, p. 42.

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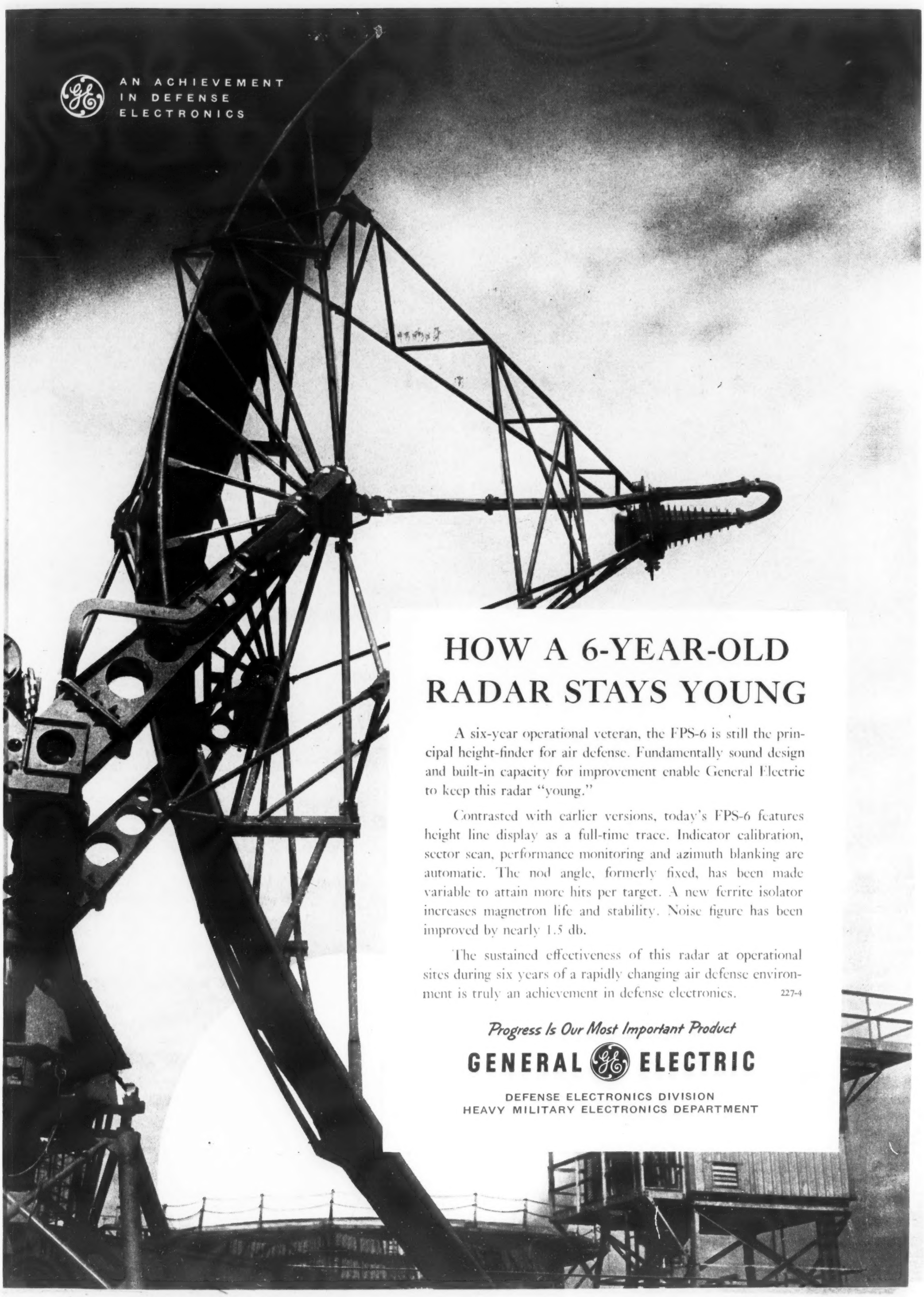

HOW A 6-YEAR-OLD RADAR STAYS YOUNG

A six-year operational veteran, the FPS-6 is still the principal height-finder for air defense. Fundamentally sound design and built-in capacity for improvement enable General Electric to keep this radar "young."

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The sustained effectiveness of this radar at operational sites during six years of a rapidly changing air defense environment is truly an achievement in defense electronics. 227-4

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ANDROMEDA NEBULA—U.S. NAVAL OBSERVATORY PHOTO

BY MAJOR GENERAL EARLE R. COOK, USA—DEPUTY CHIEF SIGNAL OFFICER

MAN HAS ALWAYS TRIED to reach beyond the horizon—both figuratively and literally. In communication, he has especially sought to overcome the earth's physical limits.

The Indian signaled with blankets and smoke to tribesmen beyond the natural curving barrier of the ground. He rode his pony atop high places where he could be seen—zigzagging, circling, dismounting and mounting. Each movement communicated information.

A young military surgeon became intrigued with the principle of the deaf and dumb sign language and developed a visual flag signaling system for communication. Using towers and high natural vantage points, his early signalmen during the Civil War waved flags in accordance with his code to convey intelligence and orders. His later "Flying Telegraph" trains were designed to further overcome the distance and geographical barriers to communication.

This officer—Major A. J. Myer—focused a specialized effort on military signaling. He founded the U. S. Army Signal Corps and became its first Chief Signal Officer and director of the first full-time signaling organization for a national army. That embryonic Signal Corps becomes 100 years old this year.

Yet even in Myer's imaginative vision, he probably could not foresee the wholesale changes which were to occur in communications during this subsequent century of his Corps' service. Even he could not guess the hurtling progress man's ingenuity would devise.

An evolution of almost revolutionary character took place in the last fifty years of the 19th century. *In less than one man's lifetime*, a group of inventive pioneers world-wide—Morse, Nipkow, Marconi, Baudot, Bell and Zworykin—produced the practical means for telegraph, telephone, teletypewriter, radio and today's television.

Now, in the last half of the 20th century, we are embarked on another tremendous program of exploration, discovery and exploitation in the vast new region of outer space. Man looks into an infinity of potential as limitless as space itself.

Missile developments of the Defense Department have provided us the essential components for a new means of transportation—space vehicles. Of telling importance to the communicator, some of these equipment and technique developments will serve us well for communications to and from outer space. And they will also help us to solve some of the vexing problems of communicating between widely separated points on earth.

That we are only at the threshold of this promising new world—or maybe, promising *outer* world—can be seen in the relative newness of space vehicles and satellites themselves.

Today, we face oportunities and problems as challenging as those faced by earlier men and women a few generations ago. There is again the need for improved communica-

tions—compounded by the compelling advances in space work. There is a desperate need for more adequate, more reliable, global communications, not only for the military, but also for the manifold number of civilian applications: communicating between countries, radio and television world-wide news and entertainment broadcasts, storm and disaster warning networks, and ultimately, space navigational, intracommunication and control systems.

Aside from man's eternal inclination to improve himself and his communications, what makes us look toward the day when we can have a system of comunicating satellites stationed in space around the earth? Are today's communications so woefully short of man's requirements?

I don't believe the answer can be a categorical, yes or no. Just as the colored signal flags gave way to the telegraph, and the telegraph to radio relay, it is more that our times today demand comparable advances.

There's nothing fundamentally wrong with the commercial communications systems within the United States, or within some of the western European countries. The same can be said of the military systems of the Services, which are supported by civilian communication facilities. There are some who feel that domestic or interior communications advances have actually moved faster than man's ability to assimilate them.

But the situation isn't the same for transatlantic or transpacific communications. We have serious problems with cable and radio facilities when it comes to long distance global communications—particularly in the polar regions.

Our existing systems are overburdened with traffic. Besides lacking solid reliability, because of atmospheric conditions and other factors, they're not versatile or very flexible.

One example is the global transmission of video signals. There is no commercially feasible transatlantic or transpacific television service.

For long-range voice and coded transmission, of course, we have excellent marine cables. They lay across the bottoms of the oceans and connect us with other continents. We also have radio techniques using what is called tropospheric or ionospheric scatter and other advanced systems. In the former we essentially use the tropospheric or ionospheric layers above the earth as a kind of reflector and bounce our signals back to earth at some distant point.

All of these, however, are overshadowed by the tremendous possibilities of satellites—orbiting earth satellites—for the relay of audio and video communications. In its simplest form, the satellite replaces the natural space layers from which we bounce our signals in the conventional systems. We can put special communications equipment inside the satellite which will amplify the signal or store it before relaying it back to the earth receiving station or another satellite.

We knew as early as the end of World War II that it was feasible to transmit signals through outer space. The large experimental Diana radar at Fort Monmouth, New Jersey, successfully bounced signals off the face of the moon in 1946 and received them at the ground site. (See Signal Cover October 1957)

Communicating satellites will probably never replace all the various existing systems of communications. Satellites will, however, ultimately provide a reliable and efficient means of spanning the oceans and polar regions—providing truly global communications for both military and commercial purposes.

Defense in Outer Space

Now, I'd like to tell you about some of the programs and projects of the Defense Department for communications satellites in outer space. Many of these had their origin four, five, even as much as ten years ago. But until recently, they proceeded at a moderate pace.

In the years after Korea and before the Sputniks, our national security was based mainly on a policy of massive retaliation—with a balanced budget. There was no real urgency of scientific military effort in the realm of outer space. Economy and nuclear weapons were the watchwords of our military strategy.

The sudden and positive appearance of Soviet satellites brought sharp reactions and abrupt changes in our scientific philosophy. The potential of our space activities was recognized, and our scientific work in this field proceeded with greater vigor. The SAC dispersal program was expedited. The Atlas program was undertaken. The Navy stepped up work to provide an operational Polaris missile. The Army developed Redstone and Jupiter missiles. In the field of communications satellites, we extended our plans and accelerated the development of our first hardware.

The first military experiment in space communications began to take shape a little over a year ago. It was called Project SCORE—the initials standing for: *S*ignal *C*ommunications by *O*rbiting *R*elay *E*quipment. It was a development of the Army Signal Corps Research and Development Laboratory—under the jurisdiction of ARPA, the Advanced Research Projects Agency of the Defense Department.

The Army-developed communications "package" was aboard a satellite placed in orbit by an Air Force Atlas missile on December 18, 1958. This experiment—Project SCORE—demonstrated for the first time that voice, teletypewriter, and even *multiple* teletypewriter signals could be received, stored, and then retransmitted by a satellite orbiting in space. The communications satellite was used successfully as both a delayed repeater—where the signals are temporarily stored and sent down later—and as a real-time relay station, where the signals are relayed directly to another ground station as they are received.

This marks the first chapter of exploration and discovery in an entirely new dimension of modern communications.

It is, however, only the beginning.

Our space work continues on several different technical fronts—and at a relatively fast pace, considering the unique problems that confront us.

Chief among these problems is propagation, the transmission of electromagnetic waves—the act of making our signals move through the air or space.

Signals to and from space relay stations travel greater distances than many of us realize—beset by atmospheric interference, cosmic influence, fading, distortion, and other effects. On occasion, these kilo-megacycle waves display tantalizing and unpredictable behaviour.

We sometimes feel an urge to remind the nontechnical public that the surprising thing about radio and video communication is *not* that it sometimes fails us, but that it even works at all.

Overcoming these many obstacles and solving these peculiar problems of propagation are often matters of good engineering design and development. Frequently, altogether new scientific areas must be explored in order to produce adequate types of communications satellites.

This is what the Department of Defense is doing—through research, development, and operations by *all* of the military services in close cooperation with the communications-electronics industry.

(*Continued on page 9*)

TRUE NORTH... anywhere–any time–any weather

A portable field instrument that finds true north automatically is now available to America's new mobile Army. It is called ABLE and has been TYPE CLASSIFIED by the U. S. Army, TO & E No. LIN279415. ABLE swiftly determines true north . . . day or night, in all weather, and anywhere in the world up to latitudes of 70 degrees.

The simplicity, speed, and precision of ABLE compared with surveying methods means a saving in time, manpower, and equipment . . . and is in keeping with the modern Army's concept of battlefield mobility.

Heart of the 100-pound all-transistorized system is a high-precision gyro which senses true north. Its accuracy is equal to most celestial methods under tactical conditions. ABLE components have a mean-time-to-failure in excess of 3000 hours. ABLE can also provide directional orientation for field-operated mobile radar and missile launchers.

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Environment of Space

(*Continued from page 7*)

The first communications satellite —Project SCORE—was the forerunner of several other types now being developed.

All of these are part of a notable program called Project Notus which constitutes a *family* of several kinds of communications satellites. Notus is one of the few new words which is not a contracted form of anything. It is the Greek word for south wind.

First phase of the Notus Project is Task Courier — designed to provide vitally needed expansion of trunking capacities for global communications by means of delayed-repeater satellites.

In this concept, an Army-developed communications satellite will initially be placed in a circular orbit at a relatively low altitude of about 650 miles minimum. As it passes over a ground station, information is transmitted rapidly by that station to the satellite, where it is stored on magnetic tape. Later, when the satellite passes over or near the ground station to which the traffic is addressed, that ground station triggers the relay with a coded command signal—and the satellite broadcasts the traffic stored on its magnetic tape.

While a ground station is receiving messages from the satellite, the station also may be transmitting, on a different frequency, *other* traffic to be carried by the satellite to other ground stations.

The trick, of course, is to transmit and receive all of this traffic at exceptionally high rates of speed during the short period that the satellite is passing over each ground station. Our system has a traffic-handling capacity equivalent to 20 teletypewriter channels each operating continuously at a rate of 100 words per minute.

During a three-year development period beginning in mid-1960, several Courier satellites will be launched. Each communication "package" will be developed by the Army, who will also construct the ground control stations of the Courier system in Puerto Rico, Hawaii, and several other locations around the world. Each satellite will be placed in orbit by Air Force two-stage boosters.

Another task of Project Notus is to provide a real-time or instantaneous satellite repeater for two-way communications in the polar regions. This is called Task Steer, and is being developed by the Air Force.

A more advanced type of 6-hour polar satellite is also under development by the Army, known as Task Tackle. It will provide ground-to-air and ship-to-shore two-way communications, and will be launched in a polar orbit by an Air Force modified Atlas missile.

Task Decree is a real-time communications relay station aboard a satellite in a 24-hour equatorial orbit. Operating at about 23,300 statute miles above the earth's surface, a Decree satellite will travel at such a speed that the rotation of the earth will keep the space vehicle *in a fixed position* with respect to the earth. It will effectively "hover" over a given location along the equator. At this great distance, a large portion of the earth is visible to the microwave transmissions of the satellite, which acts as a relay between points on the earth separated by several thousand miles. The Army-developed communications "package" will provide a large number of voice channels plus a voice channel for aircraft communications. The Decree satellite will be launched by an Air Force modified Atlas.

A larger, heavier and more sophisticated type of 24-hour equatorial communications satellite will provide a greater traffic-handling capacity. It will be launched by an Army Saturn. (Editor's note: Saturn relates to a launching rocket with a 1,500,000 pound thrust presently being developed.)

Three or four of these equatorial satellites, properly placed in space, would be sufficient to literally "cover the world"—except for small polar areas.

Complete Global System

Ultimately, the 24-hour equatorial Advanced Decree satellites will constitute a complete global communications system, which will also include communications satellites in polar orbits.

This is truly an ambitious program, which will probably take from five to as many as ten years to complete successfully.

But, we are well on our way.

All communications satellites of Project Notus are, of course, *active* satellites—equipped with their own transmitters, receivers, control devices, solar power, and ancillary equipment.

There's *another* type of communications satellite—the *passive* satellite —without actual communications gear or equipment, moving at extremely high altitudes in outer space.

Simplest kind of passive satellite is a large aluminized balloon, about 100 feet in diameter, which can be launched from missiles. Sufficiently powerful microwave signals directed at such a balloon would be reflected back to earth—weakly, of course, but over a wide geographical area. Ground stations within that area would be able to pick up the reflected signals, providing each station included sensitive tracking and receiving equipment with highly directional antennas.

One passive balloon launched in a relatively-low-altitude orbit would provide communication between two ground-based stations for only a portion of a day. But if enough balloons were launched, instantaneous relay communications could be provided almost continually.

An alternative to launching large balloons would be to place objects of *other* shapes in orbit in such a way that they would reflect microwave signals back to earth.

While passive satellites are possibly of greatest immediate interest to broadcasters, active real-time communications satellites can also prove useful for low-power transfer of data and video information.

Although initially of considerable expense, the regular transmission of transcontinental video programs—and even trans*world* video programs —would soon absorb the cost of launching an active real-time communications satellite. The magnitude of commercial possibilities of such a privately-owned satellite relay staggers the imagination of even those of us who daily work with outer-space devices.

While we, in the Armed Services of the Defense Department, are primarily interested in military space communications, it's significant that so many of our current projects have direct usefulness to the civilian economy and are immediately applicable to commercial communications. This is only a fair exchange, because the successful completion of these space projects would not be possible without the outstanding cooperation and direct assistance of the communications-electronics industry.

Communications satellites, both military and commercial, are now certainties of the Space Age. They are no longer dreams of technical visionaries and science-fiction enthusiasts.

The future has become the present.

Man's first missile firing did more than send a vehicle into space. It catapulted man, the communicator, far beyond his earthly horizon to the unbounded promise of a vast new era of communications.

IN THIS PAPER I am going to discuss the Command Guidance System developed by Bell Telephone Laboratories (BTL) for ballistic missiles and space vehicles. First, however, I will present a brief background of the events which led to our participation in this fascinating new field.

Most of you know that the Bell Telephone Laboratories is the research and development organization for the Bell System. Our principal effort is directed toward fundamental research in the communications field and the development of new communication systems to give the best possible telephone service at the least cost to the customer. The fruits of these endeavors lead to manufacture of new electronic equipment by the Western Electric Company and its use by the Operating Telephone Companies.

Ballistic missiles and space vehicles bear little resemblance to the telephone instrument on your desk. Yet it turns out that there is a close relationship between the applicable technologies in spite of the differences in the end article.

For many years the Laboratories has been exploring the use of higher and higher frequencies for point-to-point communications. In the early thirties George Southworth at our Holmdel (N. J.) Laboratories was investigating the use of microwave frequencies transmitted in hollow pipes which we know today as waveguides.

As you know, it was the use of these high frequencies which made possible the development of precision tracking radars during World War II. Our first project in this field was a shipboard radar for the Navy developed in 1938. That work, in turn, led to a long line of radars for military use.

Another aspect of communications technology which bears directly on the subject for discussion is the computer-like aspects of switching and information handling. Here, again, the telephone technology made important contributions to computers for gun fire control and, later, for guided missiles. The real contribution was not only the computers themselves but, perhaps more importantly, the means for processing imperfect input data to arrive at a useful output for weapon control.

Our work in the field of guided missiles began in late 1944 with the study and subsequent development of the Nike family of guided missiles with which you are familiar. The method used was called "command guidance" and followed rather directly from prior work on gun fire control systems. The difference lay in the ability to steer the projectile after it left the gun barrel—so to speak.

In the command guidance system shown in block form in Figure 1, page 12, a ground installation has knowledge about the target—its position and its motions. For an antiaircraft system such as Nike, this information is obtained from a ground based precision tracking radar. It not only determines the present target location, but also provides information on motion to permit prediction of its future position when it will be met by the defensive missile. Since the missile can be controlled in flight, maneuver of the aircraft can be countered continuously to effect a "kill."

For ballistic missiles and space vehicles the target position is known by the ground installation from its geographical coordinates for earth targets, or from knowledge of the celestial bodies in the case of extra-terrestrial targets. Knowledge of target motion is required in these cases also, because of earth rotation and movement of the celestial bodies. Unlike the aircraft, however, the motion of targets for ballistic missiles and space vehicles is fully predictable in advance. For example, we do not expect the lunar orbit to suddenly deviate from the path

Operating console and plotting board in control building

COMMAND GUIDANCE FOR BALLISTIC MISSILES AND SPACE VEHICLES

BY W. H. C. HIGGINS, DIRECTOR OF MILITARY ELECTRONIC DEVELOPMENT, BELL TELEPHONE LABORATORIES, WHIPPANY, N. J.

it has followed for millions of years.

With this knowledge of target position and motion, it is now possible to send a missile on a path which will intercept the target at the end of its flight. In the command guidance system this is accomplished by tracking the missile during its flight, comparing its course with the desired course, and sending steering commands to correct the flight path if it deviates from the desired one. In the anti-aircraft case, the guidance must be continued throughout the flight because of the likelihood of target maneuver. Such maneuvers must be countered by sending appropriate steering commands to the missile all the way to intercept.

The situation is quite different in the case of ballistic missiles and space vehicles. For such missiles it is necessary only to guide the vehicle during a portion of its flight. If the vehicle is brought to the proper position and speed at a point outside the earth's atmosphere, the vehicle will continue to its target in free flight under the laws of celestial mechanics. Thus the problem for the guidance system is to steer the missile to a point at which the position and velocity are correct for free flight to the target. At this point, thrust is determined by a command from the ground and the vehicle continues on a ballistic path. The guidance phase is sometimes likened to a very long gun barrel.

Figure 2 illustrates four possible missions for vehicles of the type under discussion. At the upper left is the ICBM which may be aimed at an earth target a quarter of the way around the globe. At the upper right is an earth satellite being guided into orbit. The lower left is a lunar probe, and the lower right an interplanetary probe.

A common attribute of all these missions is that guidance is essential only during the early portions of the flight. If the vehicle could be brought to the exact conditions of position and velocity outside the earth's atmosphere, no further guidance would be required. It turns out that sufficient precision can be achieved to make this possible for a large variety of missions including lunar probes. For the more extended interplanetary missions, some form of mid-course or terminal guidance will probably be necessary depending upon the mission requirements. It should be noted, however, that such guidance is only required because of the extreme precision which would be necessary to achieve the desired free flight conditions.

Even if mid-course guidance is to be used, it is desirable to have great accuracy in the initial propulsive phase since this will minimize the total propulsion requirements and thus increase the possible payload.

Now let us take a closer look at the guided phase of the flight. Figure 3 shows this in more detail. Here I have depicted the early phase of the trajectory for a two-stage missile. At the end of first (or booster) stage propulsion, that stage cuts off and is dropped from the vehicle to reduce the mass which must be further accelerated. The second stage may have a main motor and a low thrust vernier motor for accurate velocity control. For space vehicles still more stages may be necessary to obtain the desired velocity.

The control problem for the guidance system is to control the flight so that the final stage of the vehicle is brought to the correct position and velocity for the desired free flight trajectory. At this point thrust is terminated by command. Strictly from the guidance point of view, the prior flight history is of no importance. The success of the mission is determined entirely by whether or not the conditions at the thrust termination are within limits prescribed for the mission. As a practical matter,

IN THIS PAPER I am going to discuss the Command Guidance System developed by Bell Telephone Laboratories (BTL) for ballistic missiles and space vehicles. First, however, I will present a brief background of the events which led to our participation in this fascinating new field.

Most of you know that the Bell Telephone Laboratories is the research and development organization for the Bell System. Our principal effort is directed toward fundamental research in the communications field and the development of new communication systems to give the best possible telephone service at the least cost to the customer. The fruits of these endeavors lead to manufacture of new electronic equipment by the Western Electric Company and its use by the Operating Telephone Companies.

Ballistic missiles and space vehicles bear little resemblance to the telephone instrument on your desk. Yet it turns out that there is a close relationship between the applicable technologies in spite of the differences in the end article.

For many years the Laboratories has been exploring the use of higher and higher frequencies for point-to-point communications. In the early thirties George Southworth at our Holmdel (N. J.) Laboratories was investigating the use of microwave frequencies transmitted in hollow pipes which we know today as waveguides.

As you know, it was the use of these high frequencies which made possible the development of precision tracking radars during World War II. Our first project in this field was a shipboard radar for the Navy developed in 1938. That work, in turn, led to a long line of radars for military use.

Another aspect of communications technology which bears directly on the subject for discussion is the computer-like aspects of switching and information handling. Here, again, the telephone technology made important contributions to computers for gun fire control and, later, for guided missiles. The real contribution was not only the computers themselves but, perhaps more importantly, the means for processing imperfect input data to arrive at a useful output for weapon control.

Our work in the field of guided missiles began in late 1944 with the study and subsequent development of the Nike family of guided missiles with which you are familiar. The method used was called "command guidance" and followed rather directly from prior work on gun fire control systems. The difference lay in the ability to steer the projectile after it left the gun barrel—so to speak.

In the command guidance system shown in block form in Figure 1, page 12, a ground installation has knowledge about the target—its position and its motions. For an antiaircraft system such as Nike, this information is obtained from a ground based precision tracking radar. It not only determines the present target location, but also provides information on motion to permit prediction of its future position when it will be met by the defensive missile. Since the missile can be controlled in flight, maneuver of the aircraft can be countered continuously to effect a "kill."

For ballistic missiles and space vehicles the target position is known by the ground installation from its geographical coordinates for earth targets, or from knowledge of the celestial bodies in the case of extra-terrestrial targets. Knowledge of target motion is required in these cases also, because of earth rotation and movement of the celestial bodies. Unlike the aircraft, however, the motion of targets for ballistic missiles and space vehicles is fully predictable in advance. For example, we do not expect the lunar orbit to suddenly deviate from the path

Operating console and plotting board in control building

COMMAND GUIDANCE FOR BALLISTIC MISSILES AND SPACE VEHICLES

BY W. H. C. HIGGINS, DIRECTOR OF MILITARY ELECTRONIC DEVELOPMENT, BELL TELEPHONE LABORATORIES, WHIPPANY, N. J.

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With this knowledge of target position and motion, it is now possible to send a missile on a path which will intercept the target at the end of its flight. In the command guidance system this is accomplished by tracking the missile during its flight, comparing its course with the desired course, and sending steering commands to correct the flight path if it deviates from the desired one. In the anti-aircraft case, the guidance must be continued throughout the flight because of the likelihood of target maneuver. Such maneuvers must be countered by sending appropriate steering commands to the missile all the way to intercept.

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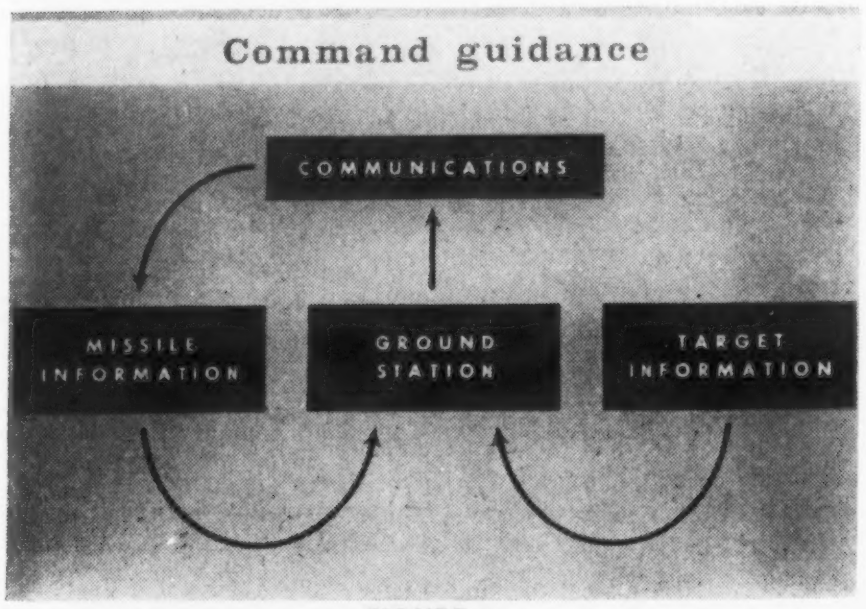
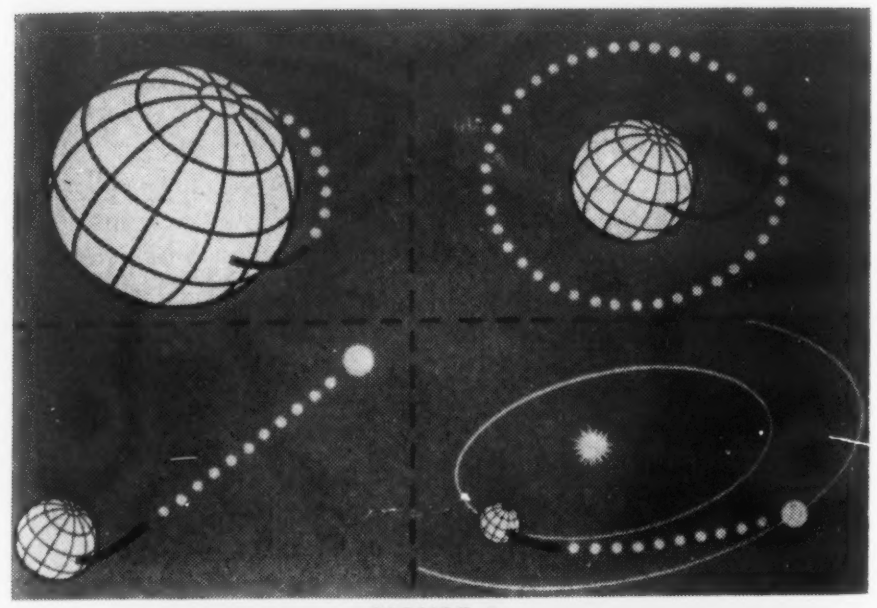


FIGURE 1



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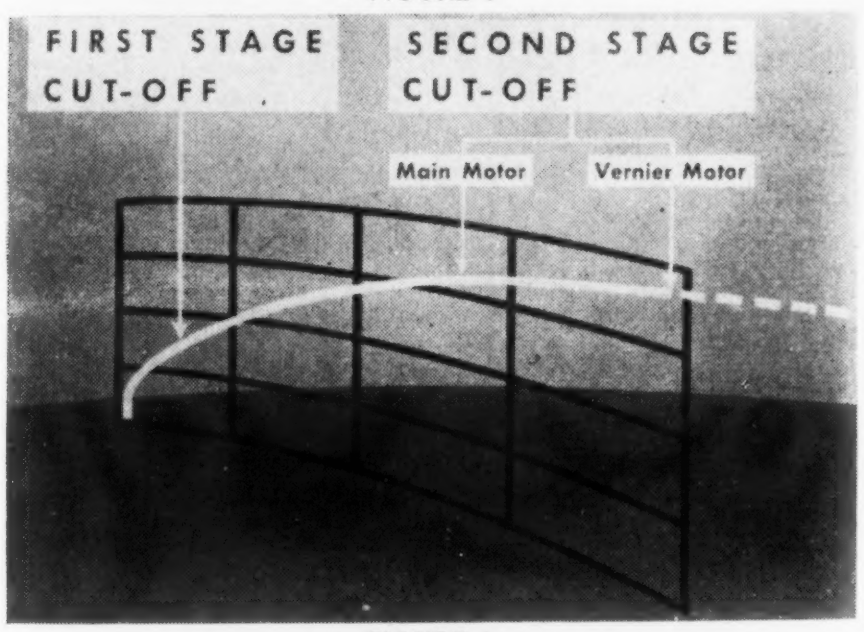

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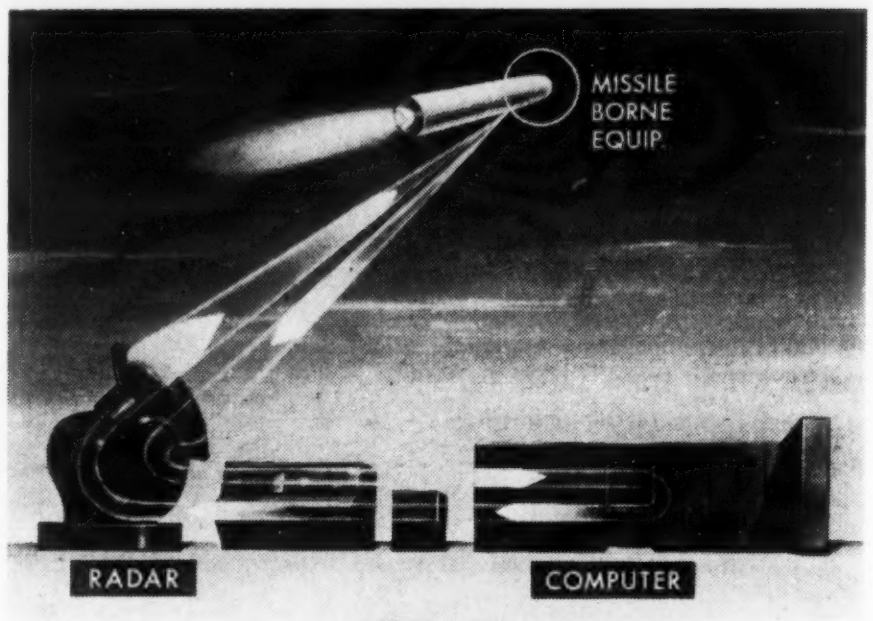
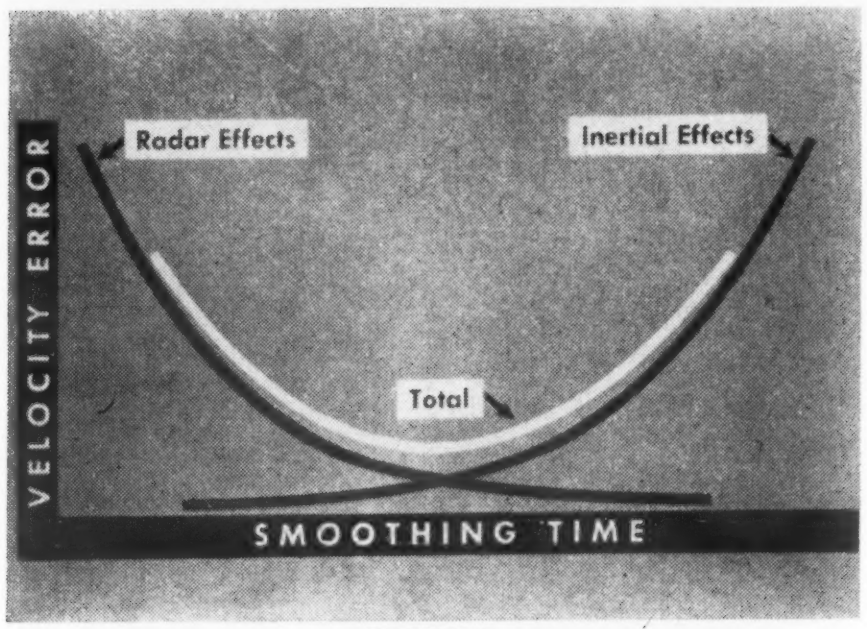


FIGURE 4



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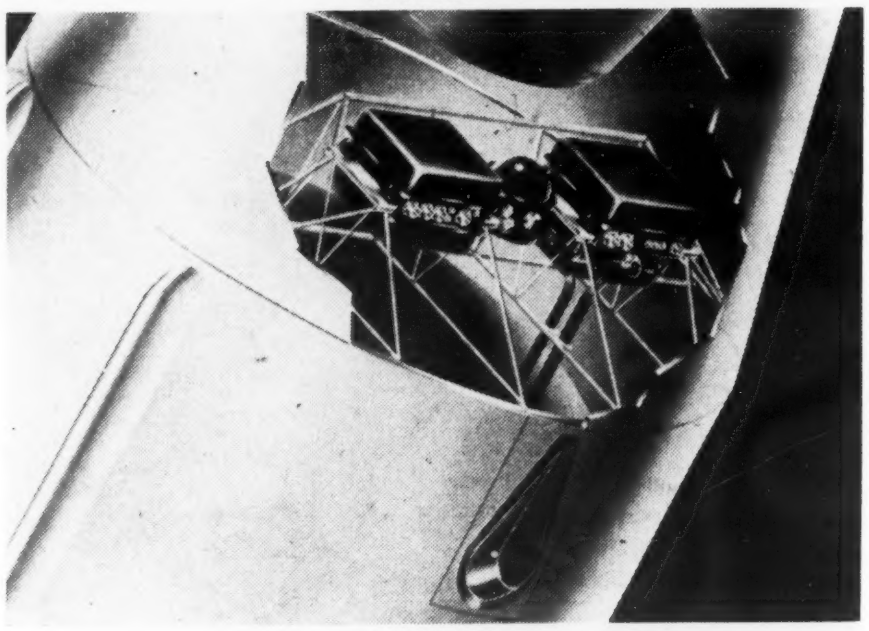


FIGURE 6

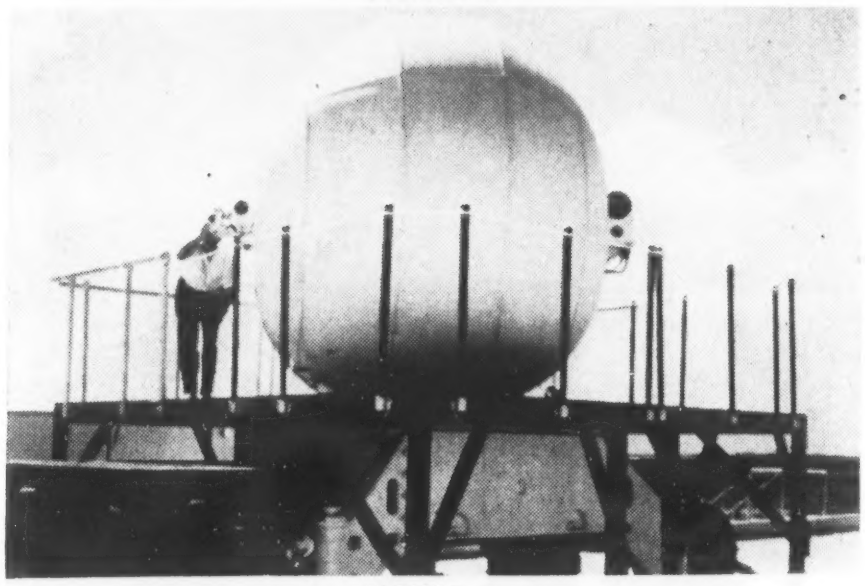


FIGURE 7

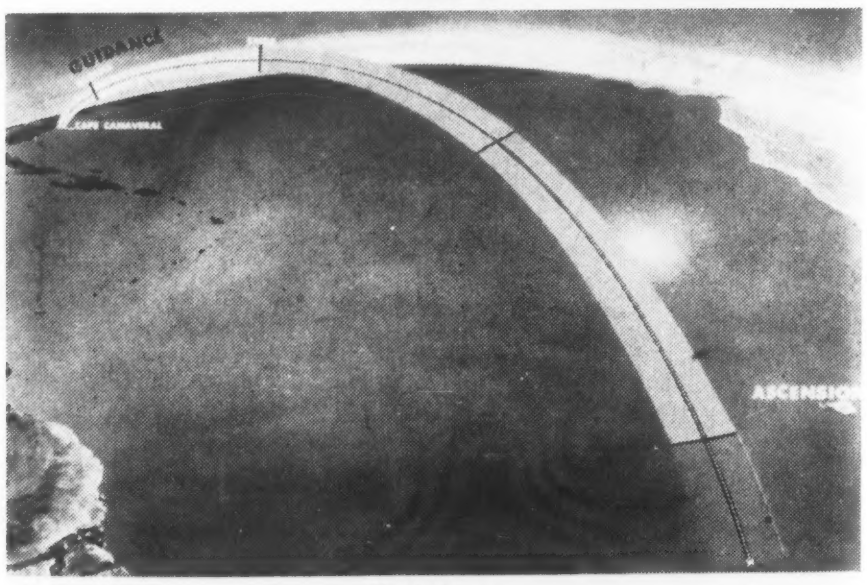


FIGURE 8

of course, the early trajectory generally is shaped to achieve efficient propellant utilization in order to maximize payload.

The principal elements of the Bell Laboratories Command Guidance Systems are shown in Figure 4. Our work on this system began with a study of the guidance problem for ballistic missiles in 1954. The concept you see here was the result of that study. In the following year the Air Force asked us to undertake its development for use with the Titan ICBM. Our work has been carried out in collaboration with the Air Force, Western Electric Company, Remington Rand Univac Division of Sperry Rand, the Martin Company and Space Technology Laboratories as a part of the Air Force Ballistic Missile Program.

In Figure 4 you see a precision tracking radar which follows the missile in flight and makes precise measurements of its trajectory. These are fed to a digital computer in which the desired trajectory has been stored prior to flight. A comparison is made between actual and desired flight path, and any deviation is coded into a command which then is transmitted to the missile over the radar beam. When the correct conditions for free flight have been obtained, a motor cut-off command is generated in the computer and sent to the missile to terminate thrust.

In the missile, electronic equipment receives the ground radar pulses and decodes the commands for execution by the missile. The received pulses are also used to trigger a beacon transmitter which provides a point source of strong signal to the ground radar for accurate tracking. Since the only functions to be performed in the missile are receiving, decoding, and beacon response, this expendable equipment can be quite simple. It can be made light in weight, requires little power, and can be made very reliable. All of the complex equipment remains on the ground in a favorable environment and can be used repeatedly.

Actually, the guidance problem is not as simple as I have made it appear. Accuracy requirements demand considerable sophistication in the processing of the radar data. In spite of the precision of the tracking radar there is a residue of tracking "jitter" which would be quite unacceptable for use in simple velocity computations. Fortunately, a great deal of work has been done at BTL over the years in the handling of such data for gun fire control and guided missiles. The techniques involve "smoothing" of the radar data to filter out high frequency jitter representing motions which it would be impossible for the missile to make.

If one "smooths" or averages the velocity computed from position measurements over a long time interval a more accurate knowledge of velocity is obtained. But there is a penalty. The velocity so obtained is delayed from present velocity. That is to say, the indicated value is that which occurred at some time in the past—about half the smoothing time ago.

This late value of velocity can be brought up to date by a form of prediction based upon a knowledge of the missile inertial characteristics—its propulsion and its control system.

The accuracy with which one knows these latter characteristics of the missile becomes less as the prediction time is increased. This is due to auto-pilot gyro drift and uncertainties in motor thrust. Thus, long smoothing reduces radar jitter but increases prediction errors.

The situation is depicted in Figure 5 where velocity error is plotted against smoothing time. It will be seen that errors due to radar jitter decrease with smoothing time, while inertial errors increase. This gives rise to an "optimum" smoothing time, the choice of which results in very precise velocity determination.

The optimum combination of radar and inertial information has led to the term "Radio-Inertial" which is often applied to this Command Guidance System.

The missile borne electronic equipment which has been developed for this system consists of three units together with antennas. These are the receiver and decoder and the beacon transmitter. In the Titan missile they are mounted in the forward compartment of the second stage, as shown in the artist's view in Figure 6. One of the antennas is seen covered by a fiberglas radome. Power is supplied by a battery inverter.

As a part of our work in the Air Force Ballistic Missile Program, we have installed two ground guidance stations at the Atlantic Missile Range, Cape Canaveral. These are used for the research and development program and are, accordingly, more versatile than required for tactical deployment. The installation at the Cape comprises two tracking antennas—one for each of the two systems—on a mound outside the control building. Missile gantries are installed forward and at a distance beyond the ground guidance stations. Control equipment is housed in a large building, and diesel engine driven power sources in the smaller adjacent building.

A close-up of one of the antennas is shown in Figure 7. The roughly spherical shape is a radome which protects the antennas from the elements. The antenna itself is a paraboloid dish with four-horn monopulse feed in a Cassegrainian configuration. The antenna rotates in azimuth and elevation, and supplies position data in these coordinates from digital code wheels. On extensions of the elevation shaft are mounted a telescope on one side and a TV camera on the other. The latter is used to give operators in the building a view of the missile prior to launch and during early phases of flight. The actual tracking, however, is fully automatic from lift-off. The telescope provides a means of accurately bore-sighting the antenna.

Inside the control building is an operating console and plotting board. Here the operators check initial alignment during countdown, and monitor the tracking during flight. The plotting board provides an inked trace of the plan and elevation path of the missile. It provides a permanent record of the flight and acts as a secondary source of range safety data.

The computer is located in an adjoining room. It is a fully transistorized digital computer developed for this program by Remington Rand Univac. Desired trajectory information is stored on a magnetic drum in one of the cabinets. Several trajectories may be stored simultaneously to permit rapid target selection.

Versatility of the System

Although the system was designed primarily for Titan it is quite versatile and can be used with almost any ballistic missile or space vehicle simply by inserting the desired trajectory information into computer storage and installing the missile-borne equipment in the vehicle.

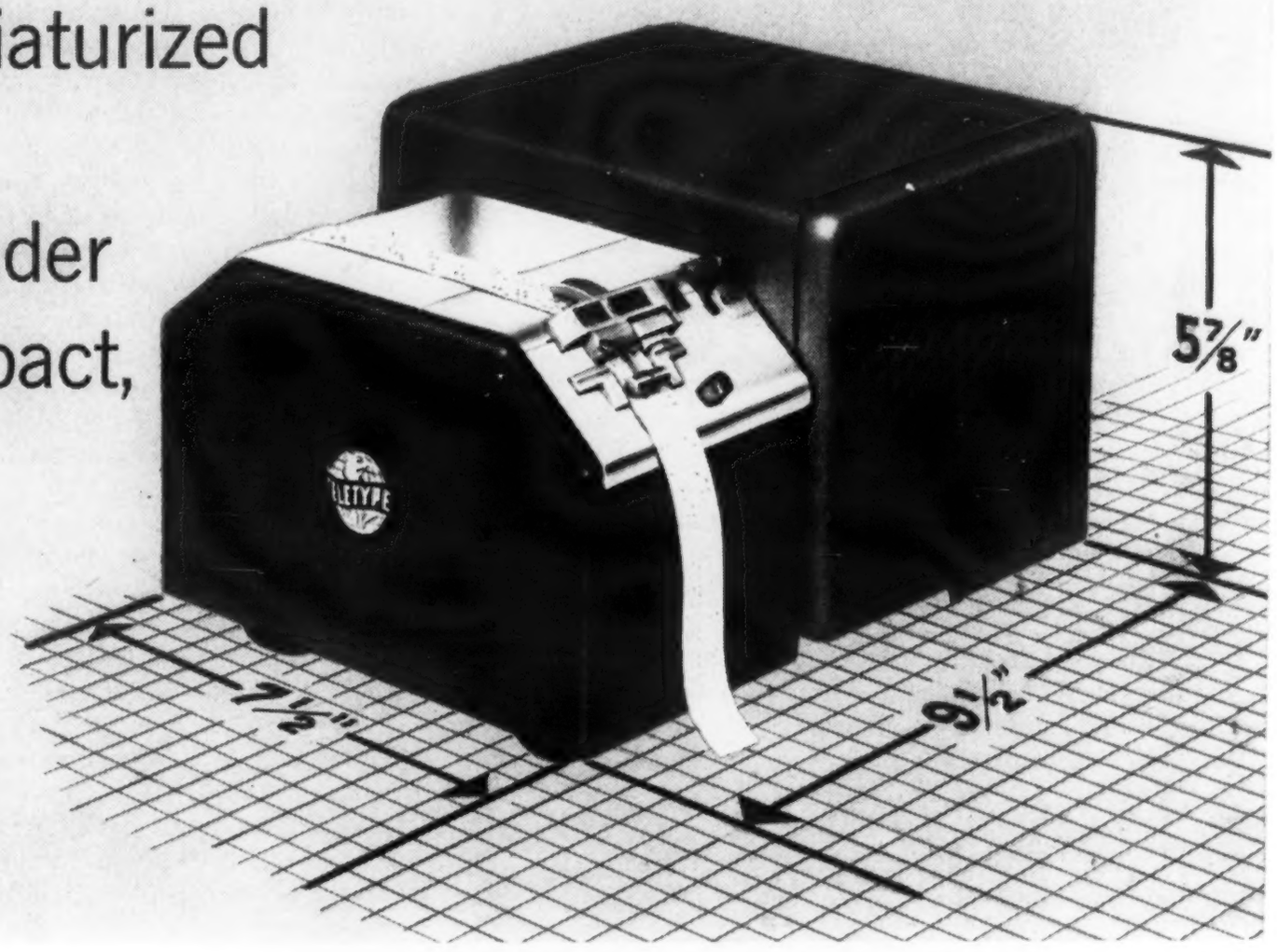
An example of this versatility is the Thor-Able II missile. In order to provide early proof of guidance capability, the Air Force authorized the use of this guidance system for the Thor-Able Re-entry Test Vehicles. These vehicles were intended to provide re-entry information on nose cones at ICBM range. The missile uses a Thor booster on which is mounted a Vanguard second stage. The nose cone under test completes the assembly. Missile-borne guidance equipment is mounted in the second stage.

The trajectory for the re-entry test vehicles is shown in

(*Continued on page* 40)

40% reduction in size and weight . . .

New miniaturized Teletype Tape Reader has compact, space-saving design



Here is a new tape reader set from Teletype Corporation—the Model 28 miniaturized LXD. It features a 40% reduction in size and weight. This new space-saver set is completely compatible with other Teletype communications equipment. It features facilities for sequential (serial) transmission, with optional contacts available for multi-wire output, and it is designed to read either chadless or fully perforated tape.

The Model 28 miniaturized LXD tape reader is made, as is all Teletype equipment, for round-the-clock, day-in, day-out service with minimum maintenance. The unit is equipped with an all-metal clutch that requires lubrication only once or twice a year, and operates with precision accuracy for continuous or intermittent transmission.

New Brochure A 4-page brochure on the new Teletype miniaturized LXD tape reader is available upon request. Write to Teletype Corp., Dept. 75B, 4100 Fullerton Ave., Chicago 39, Ill.

Specifications

Speed: . . 100 WPM (gears available for slower speeds)
Tape levels: . . . . . 5 or 6
Dimensions: . . . . . 5⅞" H, 7½" W, 9½" D.
Weight: . . . . . Approx. 15 lbs. net
Motor: . . . . . Synchronous, 115 V., 60 Cy.
Finishes: . . . . . Gray-green or custom

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SEMICONDUCTORS:

by
H. LESLIE HOFFMAN
President
Hoffman Electronics Corp.

IT IS INTERESTING to note that every major step forward in the science and art of electronics has been preceded by technical improvements in components, often in unexpected and seemingly unrelated areas. Such an event in history occurred only a decade ago when, in June of 1948, Drs. Walter Brattain and John Bardeen of Bell Telephone Laboratories disclosed their invention of the point of contact transistor. This discovery ushered in a fundamental revolution in our technology and gave us a new foundation upon which to build electronics into a wider and more useful art.

I call your attention to the fact that this invention was an American accomplishment and although the basic patent was filed by our country's largest corporation, there is no monopoly. Due to an intelligent licensing arrangement we have, in this industry, free enterprise in a most stimulating form.

As a matter of fact, many of the companies who were deeply involved in vacuum tube technology were slow to appreciate the potentialities of this new development. This provided an opportunity for new companies and for new divisions of established electronic companies to move into the void and assume leadership in pioneering this new art.

Historically, there were very few shipments of semiconductor products prior to 1953 but this has changed very radically. In 1958, industry shipments amounted to $225 million dollars. It would appear, in 1959, that shipments will be in excess of $350 million. It is forecast that within five years the industry will achieve an annual rate exceeding $1 billion.

It is my opinion that solid state physics, of which semiconductors is the most precocious child, represents an epoch in the lives of men which will be comparable in its impact to the eras of stone and iron, machines and power.

It has been our good fortune here at Hoffman Electronics to have been a part of the first decade of pioneering this new industry. Our experience in designing, manufacturing and marketing semiconductor devices goes back seven years.

Since that day, our company has sold nearly 10 million silicon semiconductor units, broadened its line to 269 different devices, and expanded its facilities to 185,000 square feet.

Dramatic pioneering and rapid progress—that is the story of the semiconductor industry and of Hoffman's participation in it to date.

Fortunately, we were right in our decision, back in 1953, in selecting silicon as the most promising of all semiconductor materials. At that time little was known of silicon but we felt that its superior operating characteristics, under more severe environmental conditions, would give devices made from it a broader market.

Based on this decision and a parallel decision to specialize in diffused junction devices, our company was able to establish many "firsts" in this pioneering period. We had the first commercially available silicon diode in 1953. The first commercial silicon solar cell in 1954. The first solar power pack for radios in 1955.

We were the first to put solar power in space. This occurred when the Vanguard I was launched on March 17, 1958. It is still transmitting after almost 23 months of continuous operation, a source of considerable gratification to us.

The Explorer VI ("Paddlewheel") satellite, launched August 6, 1959, was the first to use appreciable amounts of solar power. 8,000 of our solar cells were used in this device.

In December 1954, we introduced the first Zener reference diodes, making possible many new and revolutionary instruments and devices.

Our semiconductor devices have

electronics' new building block

been used in the Terrier, Sidewinder, Sparrow, Nike and Atlas missiles, and in addition, have played a major role in the simplification, miniaturization and improved performance of a wide variety of electronic equipments including computers, control instruments, communications devices, etc.

Although we shipped our first solar cells in 1955, they were of relatively low efficiency. The space requirements of the Vanguard satellite demanded cells having more than double the efficiency of the units then in production. The company's full resources of scientists, engineers and manufacturing specialists were concentrated on this problem and we delivered these cells with required efficiency and on time.

Already, in a period of four years, we have more than doubled the original efficiency of solar cells. This certainly is technical progress of the first order.

It has been our objective to concentrate in the development of specific semiconductor products. Since starting in the semiconductor industry, the Hoffman Semiconductor Division has shown at least a 50% sales increase each year. Each year we have had to expand our facilities and personnel to keep pace with our customers' growing requirements.

With the recent addition of our new $2 million Semiconductor Center, we have a capacity in Evanston, Ill. and El Monte, Calif. capable of producing 35 to 40 million dollars worth of semiconductor devices annually and, when fully staffed, the two plants will employ more than 2,000 employees.

Although our firm has thus far specialized in low power rectification and photo-voltaic devices, several new product classes, including transistors, are scheduled for introduction in early 1960. These new devices will have all the advantages of silicon, of our diffused junction techniques and of Hoffman's long experience in manufacturing.

Our new facilities in El Monte will produce photo-voltaic devices, transistors and other new products and will provide headquarters for the Division's research and marketing functions. The existing facilities in Evanston will continue to produce rectifiers and regulating devices and will continue to provide services for them.

Our company has consistently supported a substantial research program which has been dedicated to the advancement of the semiconductor art. We are part of a galloping technology and today's products could be outdated overnight by new technological findings. Consequently, research is a vital part of our everyday operations rather than elegant luxury.

A Look Into the Future

Now for one or two looks into the future.

The harnessing of the sun's energy has been a challenge to man throughout his history. In the past, man has attempted to utilize the heat energy from the sun without knowing that the sun could also generate electricity directly. We know that the sun actually puts 1,000 watts of energy per square yard on the earth's surface at high noon and that a goodly portion of this can be converted directly into electrical power. As an illustration, the sun delivers more power to the surface of Lake Mead than is produced by the enormous generators at Boulder Dam.

It certainly kindles the imagination as to what the future would hold if we could find an economical way of harnessing this tremendous God-given source of energy. We hear much today of our responsibilities in assisting the backward nations of the earth as a step toward world peace. One cannot help but observe that most of these countries are located in areas that have 250 days or more of sunshine and that their fundamental need is for low cost energy.

Civilization has been in past generations measured by the electrical power it consumes. Our long range planners have warned that our presently known reserves of coal and oil may be consumed within the next 50 to 75 years. But there is little doubt that the sun will continue to shine and so provide another power source, in addition to nuclear energy, to fill our needs.

Our accomplishments to date have been to supply power for low powered devices or for instruments. We look forward to the day when continual research will make it economically feasible to generate power at much higher levels.

If you should visit our new semiconductor center at El Monte, Calif., you would see two exhibits in our lobby which demonstrate the potentials of the solar converter.

Here in California we have a very real problem of water supply and it is only natural that a Californian would think of how we could convert salt water into fresh water with solar power. You would see as you enter the lobby, on the left, history's first solar powered salt water converter. You may taste the salt water before

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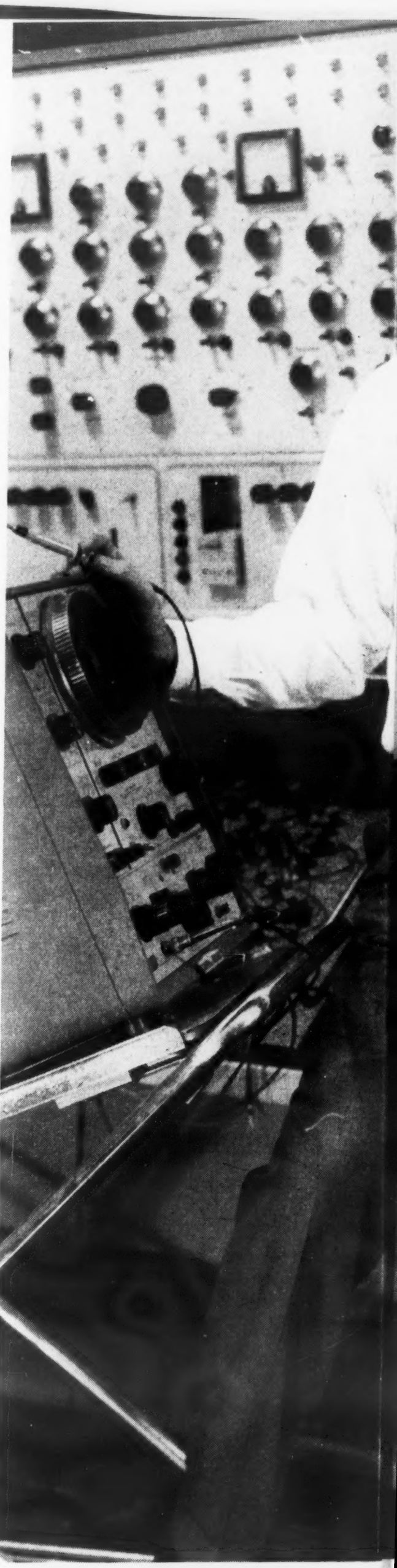

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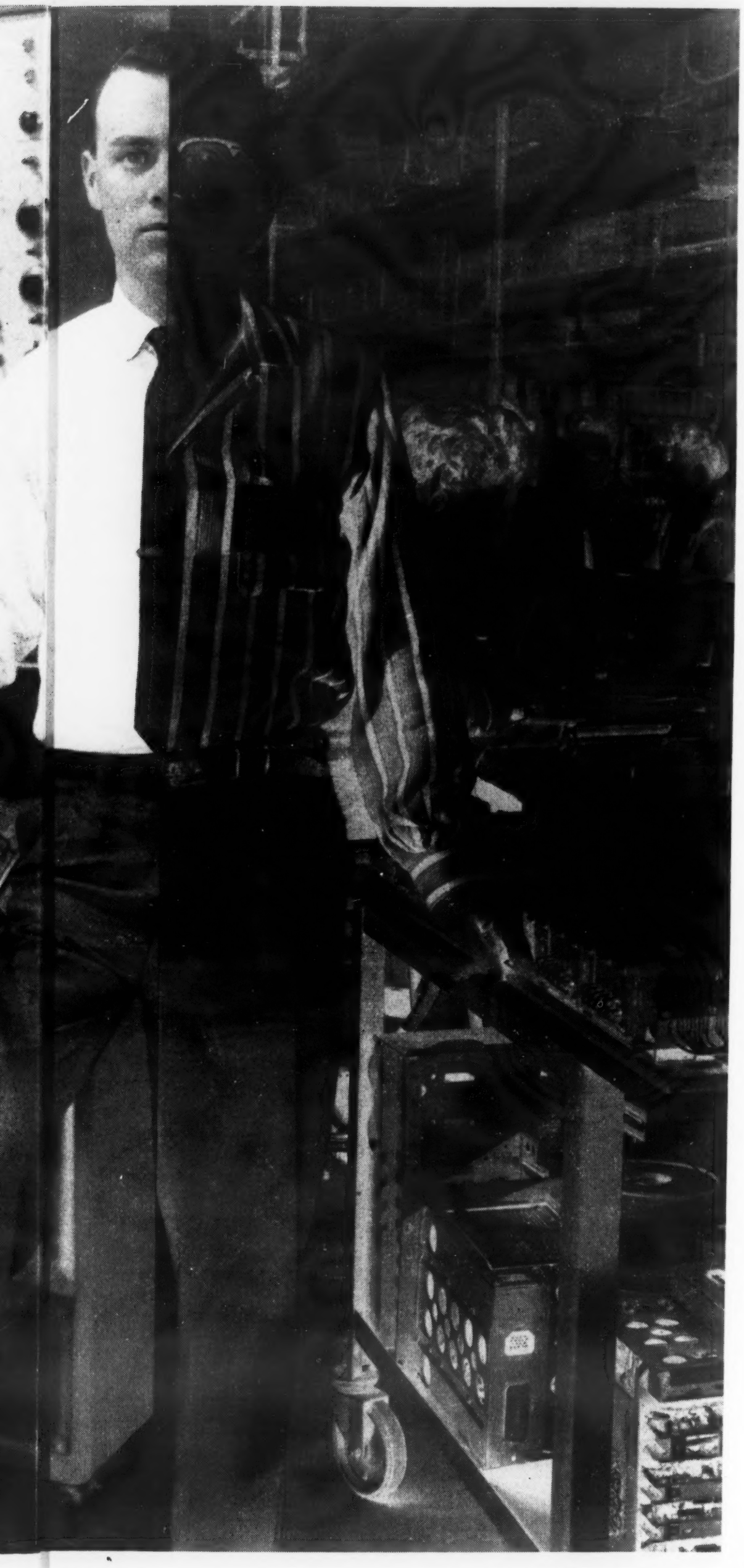

CLOUD 9 & ASSEMBLY LINE

RELIABILITY is designed into Motorola military electronic systems and equipment from the beginning... not patched on later...an inherent characteristic of all Motorola products for three decades. From *cloud nine to assembly line,* from original concept to completed military contract, uniform, dependable performance under severest operational environments is more than an objective...it is an obsession at Motorola. This spirit motivates 850 top scientists and engineers and more than 3000 technical specialists in all, deployed at Motorola's six wholly-owned facilities, exclusively engaged in electronics for defense.

Consistent reliability in a broad mix of military electronic programs has won Motorola its reputation and responsible roles in these, and other advanced fields:

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- Data Transmission, Processing & Display Programs
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- Navigation Systems & Equipment
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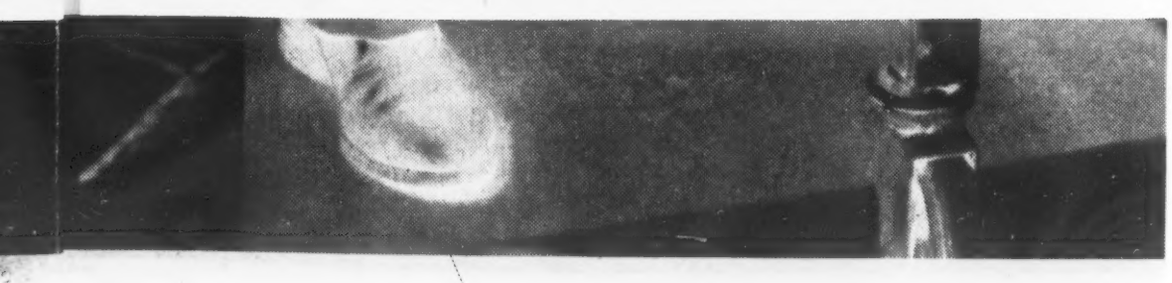
For more detailed information, a comprehensive brochure will be mailed on request.

Qualified technical personnel are invited to join recognized leaders in many fields of science at Motorola...and share in solving complex military electronics research, development and production problems. Write to the area of your choice.

Military Electronics Division



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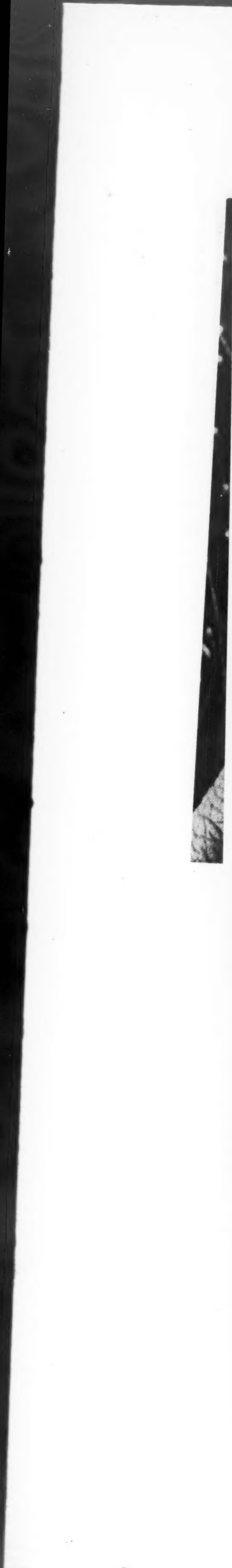
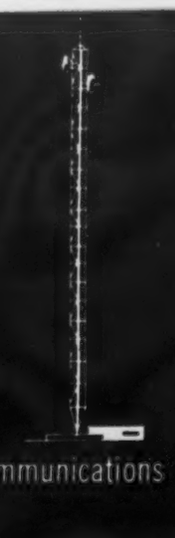
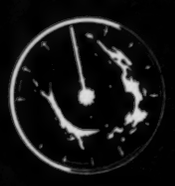




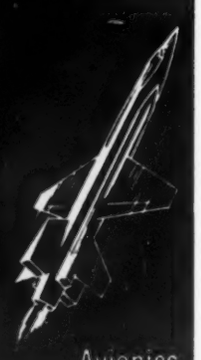
Communications

Instruments

Controls



Radar



Avionics

Missiles

Mobile Electronics

RCA's new family of ten INDUSTRIAL DRIFT FIELD TRANSISTORS

1.5 MC 12.5 MC 30 MC

RCA now offers a comprehensive group of industrial drift field transistors specifically designed for industrial and military high-frequency communications, instrumentation, controls, navigation and mobile equipment.

These application-tailored types capable of operating up to 50 Mc and above in rf amplifier service and 125 Mc and above in oscillator service will permit a large safety factor in your equipment designs and assure long-term operating reliability. They feature a maximum junction temperature rating of 100°C; a maximum transistor dissipation rating of 120 Mw in free air at 25°C, and higher ratings with heat sink; and maximum collector-to-base voltage rating of −40v, except for the 2N1226 which has a −60v rating and is intended for those critical military and industrial applications requiring such a high voltage. Millions of RCA drift field transistors now in use are your proof that RCA drift field types are today's number one answer to the designer requiring top performance and reliability at low cost.

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HIGH FREQUENCY AMPLIFIER PERFORMANCE

RCA TYPE NUMBERS

	2N1023			2N384			2N274		
h_{fe} 20 to 175 (JEDEC TO-44)									
h_{fe} 20 to 175 (JEDEC TO-33)	2N1066			2N1225			2N1224		
h_{fe} 50 to 175 (JEDEC TO-33)	2N1397			2N1396			2N1395		
50 Megacycles (sig. freq.) Common Base Circuit	**Min.**	**Type**	**Max.**	**Min.**	**Type**	**Max.**	**Min.**	**Type**	**Max.**
Power Gain (db)	18	21	24	15	18	21	—	—	—
Input Resistance (ohms)	—	25	—	—	30	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
30 Megacycles Common Emitter Circuit									
Power Gain (db)	20	23	26	16	20	24	—	—	—
Input Resistance (ohms)	—	100	—	—	50	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
12.5 Megacycles Common Emitter Circuit									
Power Gain (db)	—	—	—	24	28	32	17	22	27
Input Resistance (ohms)	—	—	—	—	250	—	—	150	—
Output Resistance (ohms)	—	—	—	—	16,000	—	—	4,000	—
1.5 Megacycles Common Emitter Circuit									
Power Gain (db)	—	—	—	—	—	—	40	45	50
Input Resistance (ohms)	—	—	—	—	—	—	—	1,350	—
Output Resistance (ohms)	—	—	—	—	—	—	—	70,000	—

2N1226—High Voltage Transistor for Video Amplifier and General Instrumentation Service is identical to 2N1224 except maximum collector-to-base and punch-through voltage rating 60v.

RCA Drift Field Transistors can be supplied to meet MIL-S-19500B specifications

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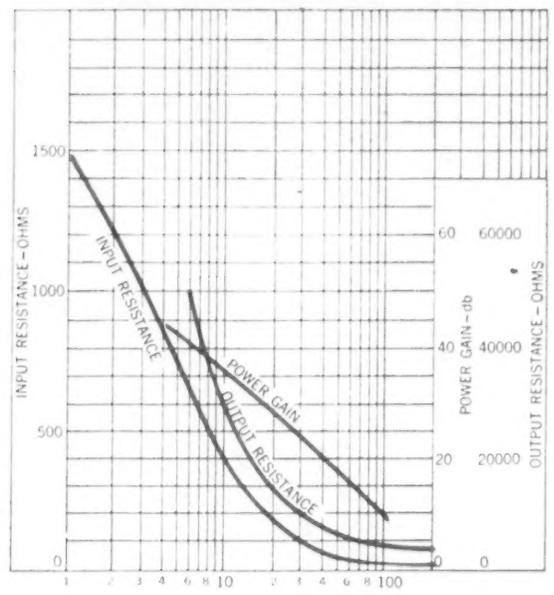


Performance Characteristics for Types 2N1023, 2N1066, 2N1397

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

RADIO CORPORATION OF AMERICA

SEMICONDUCTOR AND MATERIALS DIVISION **SOMERVILLE, N. J.**

East: 744 Broad Street, Newark, New Jersey, HUmboldt 5-3900 • **Northeast:** 64 "A" Street, Needham Heights 94, Massachusetts, HIllcrest 4-7200 • **East Central:** 714 New Center Building, Detroit 2, Michigan, TRinity 5-5600 • **Central:** Suite 1154, Merchandise Mart Plaza, Chicago, Illinois, WHitehall 4-2900 **West:** 6355 East Washington Boulevard, Los Angeles, California, RAymond 3-8361 • **Southwest:** 7905 Empire Freeway, Dallas 7, Texas, FLeetwood 2-8663 **Gov't:** 224 N. Wilkinson Street, Dayton, Ohio, BAldwin 6-2366; 1625 "K" Street, N.W., Washington, D.C., DIstrict 7-1260

Available through your Authorized RCA Distributor

Semiconductors

(*Continued from page* 16)

it goes into the converter and the fresh water as it leaves. This is a demonstration of the feasibility of this idea. We do not present it as a completed economic solution.

You will also notice a solar powered water pump in the lobby which should kindle your imagination as to what can be done on the desert.

Now let us consider what will be the effect of semiconductor devices on the home. The time is only a few years distant when home radio and television receivers will employ transistors and diodes for almost all functions now performed by electron tubes.

In addition to the *entertainment* in our homes, the semiconductors will affect their very *structure*. For thousands of years man has been heating his home by burning a fuel. This is the way it is done today, practically without exception.

Of late years, with the coming of electrical power, great strides have been made in the cooling of the home in the summer through the utilization of complex and costly machines.

In the semiconductor art there is a phenomenon called the "Peltier Effect" which can revolutionize our home heating and cooling and I believe that its exploitation will not be much longer delayed. The Peltier Effect describes the fact that dissimilar semiconductors, in contact, form a junction and become cool on one side and hot on the other with the passage of a current. Reversing the current reverses the hot and cold sides. It takes little imagination to forecast walls or large sections of walls comprised of a sandwich of these two materials. Current passed from the outside to the inside of the sandwich would cool the inner half, and when the current is reversed, would warm the inner half. Here is air conditioning at its ultimate. No moving parts, no maintenance, and indefinite life. It is obvious, too, that the same principle can be readily used for the construction of home refrigerators.

Certain crystalline materials, called phosphors, have the ability to fluoresce in an electrical field. Again, sandwiches can be made of this material between glass plates which have been prepared as transparent electrodes. A voltage between these electrodes causes the sandwich to glow with a soft and uniform light. Undoubtedly, the home of the future will be illumined by ceilings built of these devices, and as for the power to run them, I have already talked at length about the silicon solar cell. Once costs can be brought into line, and a few physical problems solved, including night-time energy storage, there is no reason why the shingles of a home cannot be made of these cells. With one kilowatt of power available per square yard of surface, it is easy to see that the average home could be provided with all the power it requires.

Nothing for a generation has stirred the public imagination or stimulated technical thinking as much as the Sputniks and our own Vanguards and Explorers. It is obvious that we are now well into the age of space and we may venture a few predictions here too.

I want to talk about the future of the satellites, not as explorers of outer space, but as technical emissaries or robots which serve the needs of the people on earth.

One of the most pressing of our needs is that of more extensive and more reliable communications between the nations of the world and to our own far-flung global interests. It is entirely feasible to utilize orbiting or stationary satellites as relay stations which, of course, would have fantastic line-of-sight ranges. Naturally these satellites will be technically complex and they will have to utilize the latest and the most sophisticated technical advances. Here is where the semiconductors will be at their best. I predict that the receivers and the transmitters in these relaying satellites will be built around semiconductor devices to the complete exclusion of vacuum tubes and I predict that they will be powered by solar cells deriving their energy from the sun.

I believe that it will not be many years before systems of orbiting satellites will be sharing the communications load with, or even supplanting, our cables and our long range radio systems, because the satellites will be able to do some things which are not possible at all for the cables or the radio circuits.

As an example, the satellites could readily provide high quality television circuits around the world. I confidently expect, within my lifetime, to sit in my living room and witness the on-the-spot happenings of a debate in the English Parliament, a cherry festival in Japan, the Olympic games in Rome, or a concert in Vienna.

Another area of interest to all of us is that of health. We are witnessing some startling uses of the semiconductors in this field. This is especially true in diagnosis. Parts of the body, which heretofore have been observable only through the use of the surgeon's knife, can now be inspected by tiny assemblies of semiconductors about the size of a pea. These are miniature radio transmitters which are safely swallowed by the patient and which, then, transmit their findings to a radio receiver outside the body. Measurements of temperature are readily made and the observation of other conditions simply awaits development.

Venturing into the future in the semiconductor field is a fascinating occupation, but as I told you at the outset, I have limited these few remarks to things which are currently on the horizon and are not in the least visionary.

I remind you that the development of semiconductor devices has progressed almost as far in the decade of their existence as vacuum tubes did in 30 years. Believe me, as time goes on you will be hearing more and more about the impact of semiconductors upon our civilization and well-being.

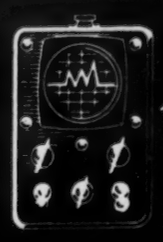
Electronics must be reckoned among the major assets of our nation, faced as we are with a threefold challenge: *First*, to maintain our military strength at a level that will deter aggression; *Second*, to sustain an economic vitality that will support this defense effort and at the same time provide for the continued growth and progress of our country and *Third*, to explore interplanetary space. In each of these vital areas, scientific and engineering progress, particularly in electronics, is the controlling factor upon which ultimate success depends.

Four hundred years before the birth of Christ a wise man in Athens, said, "The learning and knowledge that we have is, at the most, but little compared to that of which we are ignorant." His name was Plato, and what he said then is even truer today.

The new $2 million plant in El Monte is but one seed of a vast growing knowledge in the realm of solid state electronics—a realm that harnesses and controls electrical energy through the medium of the atom for man's future and for his greater well being.

We shall be working here on the threshold of a golden age in electrical living and we shall do our best to bring that age quickly and beneficially to everyone.

Communications



Instruments

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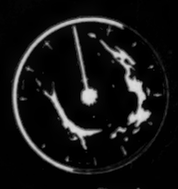

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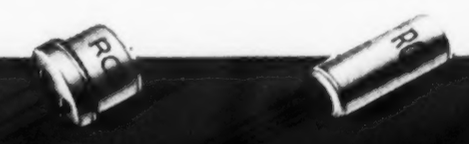

1.5 MC 12.5 MC 30 MC

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Power Gain (db)	18	21	24	15	18	21	—	—	—
Input Resistance (ohms)	—	25	—	—	30	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
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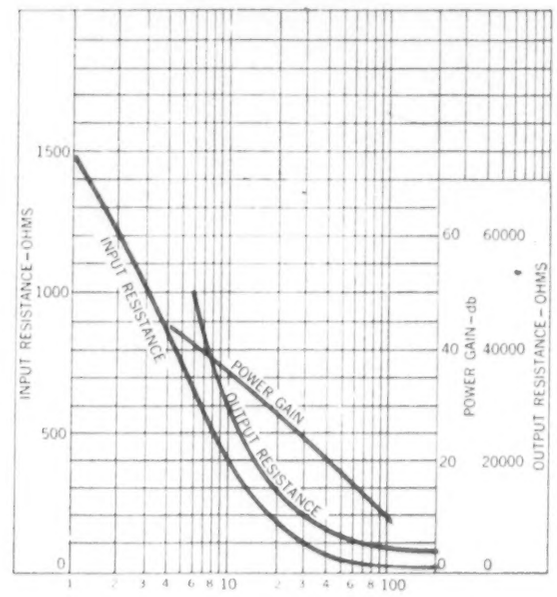

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— GOVERNMENT —

FCC YEAR END STATEMENT by John C. Doerfer, Federal Communications Commission Chairman, contains some interesting figures for the FCC's 25th year of operation. Last year 570,000 radio station licensees used over 1,700,000 transmitters—an increase of 85,000 stations and 300,000 transmitters for the year. Radio amateur stations increased 14,400 to 203,000 and 1959 saw nearly 71,000,000 telephones in the United States, more than the total for the rest of the world. Further facts are contained in Chairman Doerfer's annual report to Congress. The FCC official notes that more than 65 different categories of services utilize radio for a wide variety of purposes. From 600 AM stations in 1934, broadcast authorizations collectively today exceed 10,000, according to Mr. Doerfer, of which 3,500 are AM and over 970 and 930 are TV and FM, respectively.

NAVY SHIPBUILDING PROGRAM for 1960 calls for the construction of an oceanographic research ship to study sound transmission in the ocean. Designed to be a floating laboratory, the ship will test scientific and naval instruments and obtain scientific information needed for oceanic surveillance systems. Other ships to be built during the year include three guided missile destroyers, three guided missile frigates, four nuclear-powered attack submarines, two escort vessels, one submarine chaser, one escort research ship, one large harbor tug, one submarine repair berthing and messing barge and two landing craft.

RADAR EXPERIMENTS AT ARPA INSTALLATION in the Pacific Ocean will be conducted to detect and identify incoming ballistic missile warheads. Two high-power radars will be operated on several different frequencies in order to exploit the various flight phenomena to be experienced. These experiments conducted by the Advanced Research Projects Agency are a part of Project Defender, a research, experimentation and systems feasibility demonstration to obtain advanced defenses against extra-atmospheric vehicles.

BUSINESS AND DEFENSE SERVICES ADMINISTRATION of the Commerce Department has amended one of its defense priority regulations to insure against delivery delays which might hinder space, defense and atomic energy projects. All contractors, suppliers for production, construction and research and development for defense, atomic energy and space programs are required to identify all their defense purchase orders with the appropriate program symbols and ratings, under the new Defense Materials System (DMS) Regulation No. 1 which replaces the DMS Regulations 1 and 2 and represents the first general revision since the priority system was established in 1954.

NATIONAL SCIENCE FOUNDATION estimates total funds for scientific research and development in the United States will reach an all-time high of $12 billion for the year 1959-60, up $7 billion from the level of 1953. An NSF study found an increase of nearly 160 percent in funds used by private firms from 1953-54 to 1959-60. Expenditures by these organizations are expected to rise from $3.6 billion to a projected $9.4 billion during the period. More than half the funds expended by industry were found to have come from the Government, with 70 percent of industry's funds expended on development rather than research.

NAVAL ARCTIC EXPLORATION will take place sometime in the next three months, according to Navy officials. The U. S. Navy icebreaker USS STATEN ISLAND and the nuclear submarine USS SARGO will participate in this exploratory cruise into the Bering and Chuckchi Seas and the Arctic Basin. The purpose of the cruise is to continue the exploration of the Arctic Basin to collect oceanographic data and to establish more clearly ice conditions in the Arctic during the winter months.

PENTAGON TO ADOPT INDUSTRY STANDARDS, specifications and practices whenever and wherever possible, according to Perkins McGuire, Assistant Secretary of Defense for supply and logistics. The new procedures and policies for military standardization will help, it is believed, reduce costs of military purchases and stocks.

NATIONAL BUREAU OF STANDARDS is engaged in probability and statistics studies basic to the prediction of system reliability. The results of this work can be used in evaluating the reliability of electronic computers, weapons systems and other complex equipment, it is believed.

SEVERAL OFFICES IN THE PENTAGON have new occupants. Starting at the top, Thomas S. Gates, Jr., former Secretary of the Navy and Deputy Secretary of Defense immediately prior to his present appointment, is Secretary of Defense. Air Force Secretary James H. Douglas has been elevated to Deputy Secretary of Defense and Dudley C. Sharp has been promoted from Under Secretary of the Air Force to Secretary. Brig. Gen. Austin W. Betts has been named head of the Advanced Research Projects Agency which is now under the supervision of Dr. Herbert F. York, director of Defense Research and Engineering. Gen. Betts was Army military assistant to Dr. York.

U. S. PATENT OFFICE is using electronic computer techniques to speed up its patent searching process. For the first time the agency's punched-card file, which heretofore could be processed only on specially-built equipment, is being adapted to commercially available data-processing equipment. The automated searching system is being tested first on a huge mass of patent data covering chemical compounds that form the basis for many commonly used plastics. If the techniques work, the system may be adapted for most problems in patent searching throughout the chemical field.

IMPORTANCE OF THE MOON as a means of studying the Solar system was stressed by Dr. Robert Jastrow, Chairman, Lunar Science Group, Goddard Space Flight Center at a recent National Aeronautics and Space Administration press conference when the official stated that "the moon is more important than Mars and Venus." He continued, "The moon is the only object that we have accessible to us which has not been destroyed by erosion ... Mars, Venus and Earth all have an atmosphere and possibly had oceans at one time. But the moon is the only one that has all of its history written on it. And therefore if we want to know the origin of the Solar system it is the moon that we have to go for. I think that is the basic reason why we as scientists are so interested in the moon."

AIR FORCE JET SET WORLD SPEED RECORD by flying at speeds twice that of sound in December. Flying 1,216 m.p.h. a Republic F-105 Thunderchief completed the 100 kilometer course at Edwards Air Force Base, Calif., in 183 seconds, topping the mark of 1,100 m.p.h. set last June by a French Air Force pilot. The navigating precision demonstrated during the high speed flight over a closed circular course "is just what is needed to attack supersonic airborne targets," according to Republic Aviation Corp. which developed the plane.

CONTRACTS: ARMY: Radio Corporation of America, installation of new equipment to improve missile-measurement capabilities of the missile-tracking ship, U.S.A.S. AMERICAN MARINER, $8,911,904; Western Electric Co., Inc., engineering and technical services covering the Nike field support program, $1,705,379. NAVY: Chance Vought Aircraft Corp., Aeronautics Div., continued production of F8U-2N Crusader jet fighters, $58 million; Grumman Aircraft Engineering Corp., production of WF-2 Tracers, the Navy's first carrier-based, early-warning aircraft, $26,365,776; Martin Co., additional production of the Bullpup air-to-surface guided missile, $22,600,000; Hazeltine Corp., production of 32,000 sonobuoys, electronic submarine detecting devices, over $4 million; General Electric Co., Heavy Military Electronics Dept., development of new long range air search radar, $3,600,000. AIR FORCE: North American Aviation, Inc., continued research and development in the Minuteman intercontinental ballistic missile program, $115,000,000; Westinghouse Electric Corp., production of portable Early Warning Radar with inflatable antenna, $10,600,000; Raytheon Co., production of 7600 high power electronic tubes for use in Semi-Automatic Ground Environment (SAGE) height finding radar, $4,835,000.

— INDUSTRY —

GENERAL TELEPHONE & ELECTRONICS CORP. has announced the formation of General Telephone & Electronics Laboratories Inc., a wholly-owned subsidiary to be engaged in a wide range of scientific research activities in the communications and electronics fields. The nucleus of the research organization will be the Bayside, N. Y., Research Laboratories of Sylvania Electric Products Inc., a GT&E subsidiary.

RADIO CORPORATION OF AMERICA will consolidate its Washington, D. C., operations in a new 13-story glass and aluminum building, named the RCA building, next month. Pinckney B. Reed, RCA's vice president in charge of Washington activities, states that the structure will contain an RCA 501 Electronic Systems Center to provide data processing service for government agencies and business clients.

COLLINS RADIO CO. will develop a microwave communication system and a tropospheric scatter communication system to be installed in the Washington, D. C. area, under a $1 million contract from the U. S. Army Signal Corps. More than 120 channels will be carried on both systems. The majority of channels are simplex for links between the HF point-to-point transmitter and receiver sites and associated communication

(*Continued on page 32*)

TELECOMMUNICATIONS

Signal fires flaming across a network of some nine stations over a distance of sixty miles flashed the news of the fall of Troy to Agamemnon's palace at Mycenae. *Tele* in Greek means distance, and this—in 1194 B.C.—was *telecommunications.*

The newest and most advanced technique in telecommunications is the tropospheric scatter method using ultra high frequency signals which travel beyond the horizon, leap-frogging mountains, oceans, and other geographical barriers.

The development of tropo scatter equipment technique has been pioneered by Radio Engineering Laboratories, Inc. We at REL are responsible for the design and construction of the radio equipments for eight out of nine major tropo networks.

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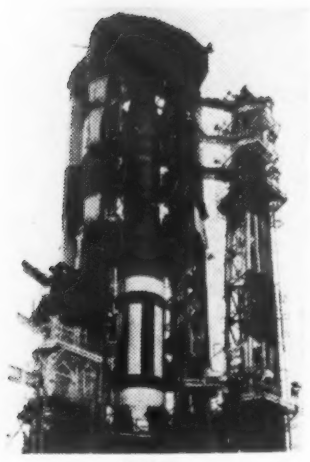

Titan

Thor

THIS PAPER on Ballistic Missile Management is divided into two parts: the criteria and techniques used for logistic management of ballistic missiles and brief personnel psychology observations related to such management.

The Air Materiel Command's San Bernardino Air Materiel Area (SBAMA) is centered at Norton Air Force Base, some 50 miles east of Pasadena. Our mission is to manage logistical support for the Thor intermediate range ballistic missile, the Atlas intercontinental ballistic missile, and the Titan intercontinental ballistic missile.

Reaching back into very recent history, when the research and development phase of the Atlas, Titan and Thor weapon systems had progressed to the point well enough defined to start fabrication of test hardware, the logistical support phase came into being.

The Air Research and Development Command, our own Air Materiel Command, Air Training Command, and the Strategic Air Command recognized the need for development of logistics calling for radical departure from systems supporting conventional weapons in 1956.

So here were weapon systems that would have no flying hour program, no post D-Day support. A missile flies but once, and then only in anger. This system would require support guaranteeing the highest readiness index around the clock, three hundred sixty-five days a year.

What would such a system look like? A plan approved in November of 1956 held the answer. Such a Logistic Support System, said the plan, must be highly responsive, reflexive in reaction, and create minimum administration at squadron level.

The following criteria were listed:

(1) Centralized knowledge of assets. This was to say that to provide a highly responsive support system, the weapon support manager had to have at his fingertips the complete world-wide logistic status for his weapon.

(2) Data processing. Only through use of high speed, electronic data processing equipment could up-to-date centralized knowledge of assets and reflex logistics be attained.

(3) Automatic resupply. If the weapon system was to be held in constant readiness, it had to be completely supported, stocked with normal, operational spares, continuously—with a zero out-of-commission objective. This was to be accomplished through electronic data processing programs designed to ship supplies automatically.

(4) Minimum administration at operational level. The business of the ballistic missile squadron is to maintain a constant state of readiness. It was not to be burdened with details of stock record accounts, reordering, and so forth. The electronic data processing equipment (EDPE) would centralize all record keeping and relieve the squadron of these details.

(5) Rapid communications. A responsive logistic system using EDPE would be largely ineffective without rapid communications. Therefore, all squadrons, contractors, and storage sites were to be directly connected with the data processing center by transceiver and teletype channels.

(6) Air transportation. The movement of replenishment spares must be tuned to all other phases of this highly responsive, rapid and reliable logistic support system. Hence, air movement would be used to the optimum.

(7) Source to user. This says it is faster to ship directly to the squadron from the source, whether it be an Air Force-stocked item at a depot or from a contractor production facility.

(8) Maximum maintenance at site. Movement of major items of equipment is both costly and time consuming. It also requires costly inventories because of lengthened pipelines. Therefore all maintenance possible will be conducted at the squadron location.

These were the basic criteria from which were moulded the advanced integrated logistic support systems to support and keep our big sticks, Thor and Atlas, on a 15-minute state of readiness. We had thus recognized new objectives, and could now proceed to implement a more advanced means of keeping Napoleon's belly full.

In late 1956 a small task force began the job of defining the logistics parameters using electronic data processing equipment. Systems designs in mid-1957 were concerned with requirements, due-ins, levels, failures, and so forth. Concurrently, another group watched the Research and Development missile test program to pick up bits of hardware knowledge. Still another provided the systems design people with technical logistics guidance.

While the integrated processing system was being firmed up, logistics people were engaged in initial provisioning, technical data collection, cataloging, and the many other initial logistic activities prior to initial operational support to the Thor and Atlas. Suddenly Sputnik I made its indelible mark across our minds. This resulted in rapid acceleration of the Thor program, which meant that this missile could not be supported initially by the integrated data processing system. Meanwhile work proceeded feverishly to complete an advanced logistic system in time to support Atlas, the 5500 nautical mile missile.

During the past two years one IBM 705 computer was installed at San Bernardino Air Materiel Area, shaken

(*Continued on page* 26)

BALLISTIC MISSILE MANAGEMENT

by
BRIG. GEN. DON COUPLAND, USAF
COMMANDER
BALLISTIC MISSILE CENTER
AIR MATERIEL COMMAND
INGLEWOOD, CALIF.

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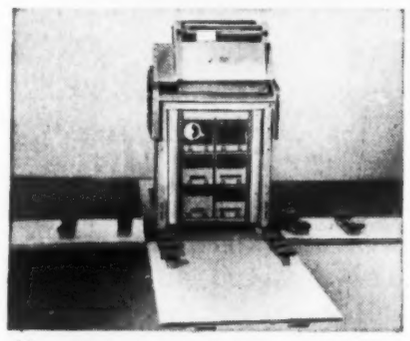
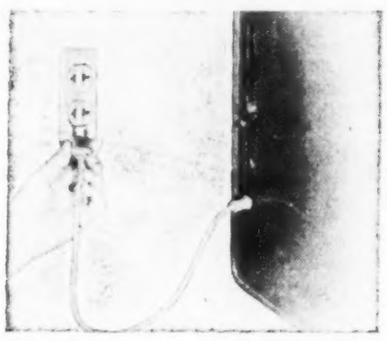


Uncrate

Roll in



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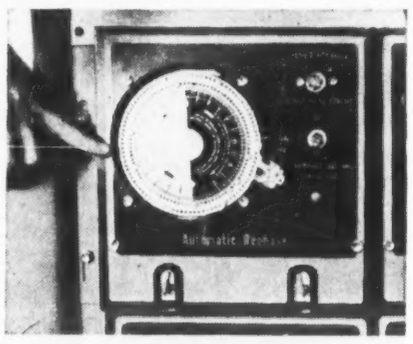
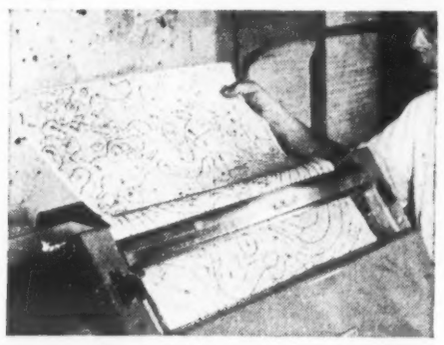
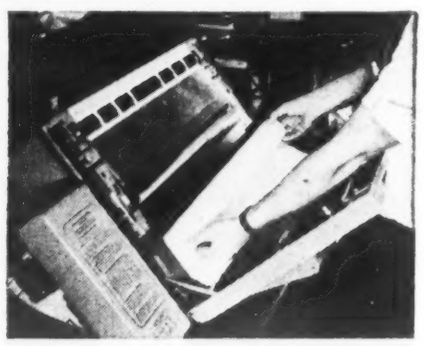


Time clock programming



Instantly visible



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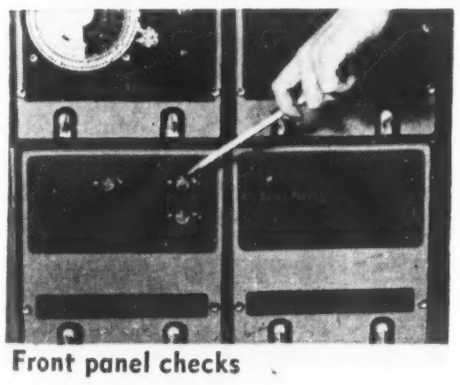
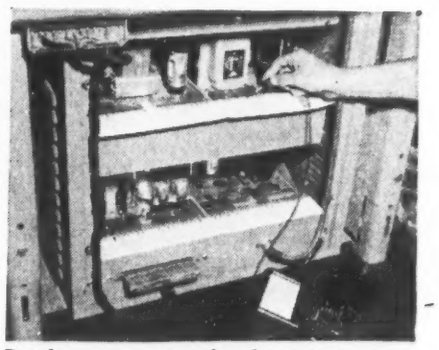
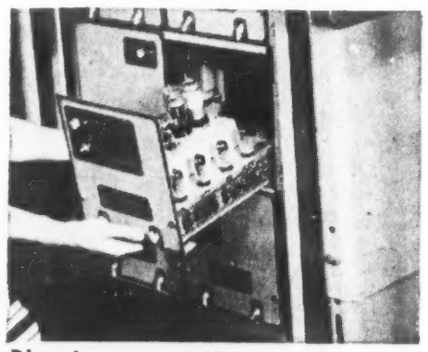


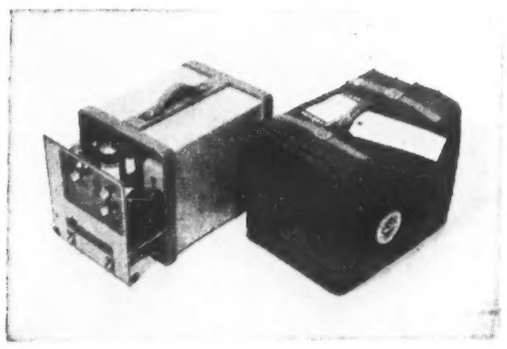
Front panel checks



Back connector checks



Plug-in construction



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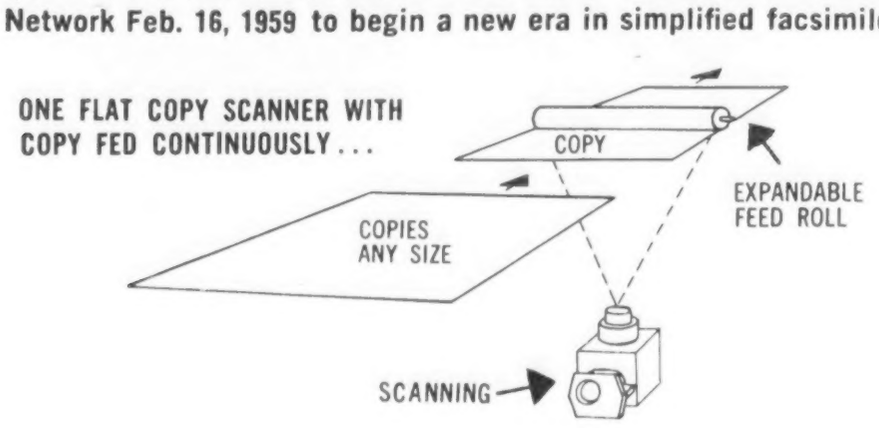

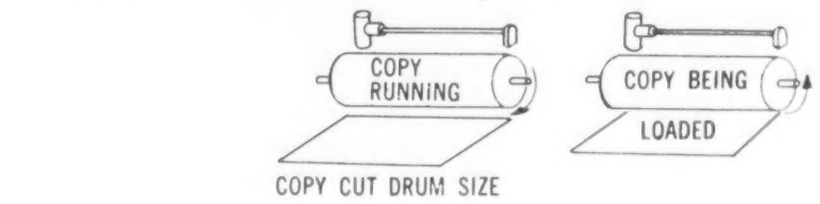

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Since 1954 Alden Facsimile Weather Map Recorders and Alfax maps have been replacing existing facsimile equipment on the National facsimile Weather Map Network at an accelerating rate.

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The new U. S. Weather Bureau's high altitude weather network, local and overseas networks are being expanded with Alden Facsimile Recorders and continuous flat copy scanners.

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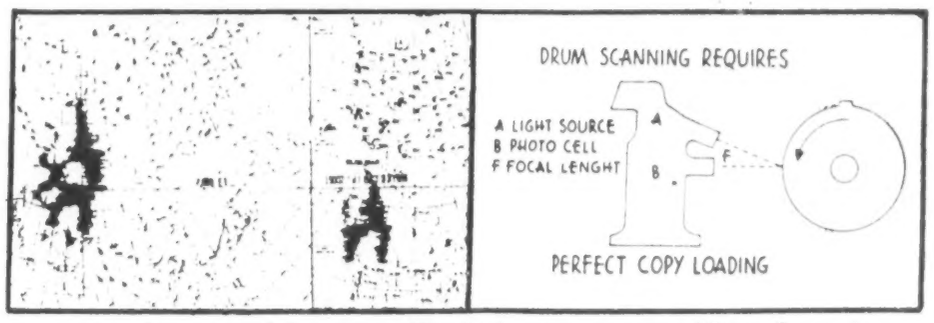
- **EASE OF COPY HANDLING . . .**

  With map sizes no longer restricted to drum mounting, continuous transmissions of maps (one after the other) with one scanner halves the space and maintenance problems, makes possible *scanning the original* plotted maps without cutting to size; map plotters and forecasters have *originals back in ½ the time.*

Flat Copy Scanner with expandable copy feed head takes maps any width or length — fed straight or kitty corner.

- **FOCUS SMUDGE ELIMINATED**



Focus smudge caused by unusually thick copy or copy lifting from drum

With copy feed rolls precisely positioning surface of map on flat copy scanner table, exact focal lengths are maintained for clear, sharp recordings.

- **MOST COMMENDED FEATURES**

  Personnel familiar with prior facsimile scanning techniques, lauding this new breakthrough in weather facsimile techniques, highly commend these features:

  - ease of copy handling
  - compactness and mobility of equipment
  - quietness and dependability of operation
  - cleanness and sharpness of copy produced

Hi-Altitude Facsimile Weather Drops . . . are available from American Telephone and Telegraph Co. for qualified companies and organizations.
For others interested in facsimile communication systems, Alden Electronics makes flat copy scanner heads and recorders in all sizes and speeds (up to 30 times present network speeds), furnishing components to qualified manufacturers, and complete systems to end customers. ***We invite your inquiry . .***

(*Continued from page* 23)

down, and debugged. Still another was placed in operation in September 1959. A Burroughs 220 computer was delivered in November 1959. The Thor program has been supported by an interim or partial advanced logistic system, and the Atlas has been supported since its operational introduction last September by the advanced system.

The Directorate of Logistic Support Management at SBAMA recently completed the initial provisioning and data collection for Thor and initial operational support for Thor squadrons at Vandenberg Air Force Base, Calif., and in the United Kingdom. The Directorate is supporting one operational Atlas ICBM complex at Vandenberg, with support planned in early 1960 for Warren Air Force Base and subsequent complexes. Initial provisioning and data collection has commenced on the Titan ICBM, with somewhat later full-scale provisioning and support of its programmed squadrons.

Transfer of executive management responsibility for Thor in early 1960, followed by Atlas and Titan, to my directorate, will free the Air Research and Development Command and the AMC Ballistic Missile Center at Inglewood to address all of their efforts to the development of new weapons.

This is the picture. I have spared you, at least, a recitation of heartaches and headaches that this violently foreshortened ballistic missile development and logistics program held for us in the Air Force and in industry.

Aspects of Missile Management Techniques

Knowing a little of the picture intimately, I am compelled to cite some aspects of today's ballistic missile management techniques.

At present our two 705 IBM systems at SBAMA account for a total of 56,000 parts on the Atlas Intercontinental Ballistic Missile; 35,000 parts on the Thor Intermediate Range Ballistic Missile, and 41,000 parts for the Titan Intercontinental Ballistic Missile, plus input of other necessary logistic statistics. Our Data Processing Center employs 225 skilled individuals. Rental costs of each month are in the neighborhood of $112,000. Maintenance, of course, is covered by this rental fee.

Let us suppose that a missile count-down is in progress. Suddenly a red light flashes in the block house. The count-down stops, technicians discover that a new part is needed within the missile system.

A hurry-up call goes from the control room in the block house to the strategic missile squadron supply. An expediting officer takes over for the part requirements. He passes the word to the stock room. Here, only minutes away from the waiting missile on the launching pad are the end products of logistic support management. Spare parts, provisioned and kept up to predetermined stock levels, serialized for compatibility with the configuration of the weapon system they support—are keys to operational readiness. Only by maintaining an inviolate level can each missile squadron be self-sufficient—independent of enemy action or technical breakdowns.

The part so urgently needed is located by bin or shelf number. Already packaged for shipment, it is quickly checked out and delivered to the waiting "expedite" vehicle, always kept standing by for the short run to the launching pad.

The average time from malfunction to delivery of the new part is 30 minutes—with a maximum allowable time of 60 minutes.

The part is delivered to technicians and the defective item is handed in return to the driver. It goes back to Squadron Supply, inspection and bench check, whereupon the squadron determines whether it has the capability to repair the item. If it is judged not squadron reparable, it is shipped immediately from the squadron directly to a contractor or Air Force depot repair facility.

All of this sounds like a simple operation, but without a data processing system, it could have taken hours to record and transmit, and weeks or months for resupply action. With this EDP technique, it can be recorded in minutes. The data is transmitted in micro seconds—and resupply action initiated immediately and automatically.

Essential facts of supply action are pencilled in on preprinted work sheets called variable data forms. The forms are relayed to a skilled key-punch operator. He goes first to the squadron master card file. In this deck is a card for every direct mission item which supports the weapon system. The master cards have been code punched before issuance with all fixed data that is available. In the key punch machine all of this fixed data—such facts as stock number, alpha coded description, predetermined supply level, and many other constants from the master card are reproduced automatically on the various transaction cards.

Next, the operator punches such variable data as are required for each transaction card—such one-time facts as time, place, and circumstances—transcribed from the pencilled work sheets into machine data code. On the transaction card every detail of parts issued is reported to the launching site for field maintenance: the resultant drop in squadron supply stock levels, inspection reports on the failed part, and the repair action which is thus generated, and the fact, time, and the method of shipment from squadron direct to the repair depot.

These carefully registered holes represent the interaction of human beings and hardware. This is part of ballistic missile logistics. To be sure of accuracy, the punched holes are independently verified in another machine that rejects any discrepancy.

At this point this basic input goes forward from the squadron at Vandenberg, in Cheyenne or in England, for example, to the electronic data processing center at Norton Air Force Base. This input, received through transceivers, provides the raw material which is refined into logistic support management. It flows in from many sources: missile squadrons, contractors, Air Force depots. It reports in code each detail of hundreds of different types of transactions.

The key-punched cards are fed into a card-tube-tape converter. Each tape reel can store the information obtained on 2500 cards, saving space, time and money. The tape reels are read by the central processing unit in the nerve center of this electronic data complex.

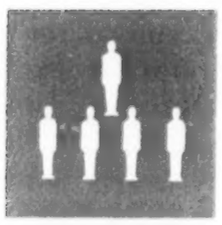
The computer operator at the console monitors the machine to insure that programmed operations go forward on schedule.

Each type of tape run has been previously programmed into the computer so that the operator needs only to press a button. For example, one run can—sequentially—check stock levels, update the master file, prepare requisitions for automatic resupply to the squadrons, schedule damaged items or assemblies for depot repair and set up a suspense file for their return—all this in a matter of minutes. To do these things the computer demands accurate data carefully processed.

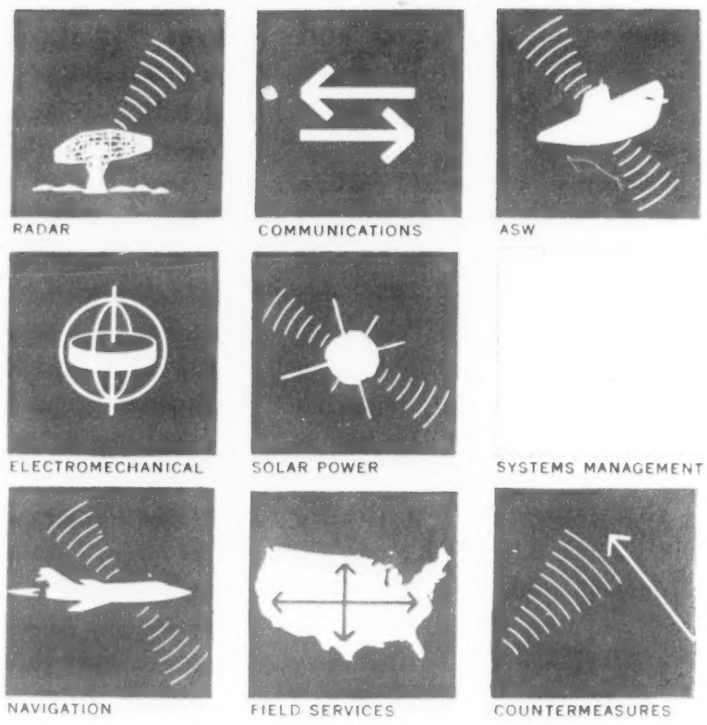
If the facts are wrong, the machine will give wrong answers, take wrong action—but signals "tilt." Cards must be correctly punched at squadron level if logistic support is to work at management level.

(*Continued on page* 56)

systems management problems?



As today's weapons and support systems become more and more complex, the need for teamwork and cooperation among contractors assumes increasing importance. Hoffman, a pioneer in the development of the TEAM concept, has acquired a unique capability in systems management. Hoffman's ability to draw together the specialized talents of several organizations is demonstrated by the success of the eight-company "Tall Tom" Team for the U.S. Air Force—an example of how Hoffman can help solve your systems management problems.



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REFRACTORY METALS

part 1

Editor's Note: Since some of our AFCEA Chapters now sponsor educational programs for high school students, we will, from time to time, publish articles in SIGNAL which will provide information of educational value for those interested in the science field.

WE SEE MANY PICTURES these days in the press and on television of the firing of rockets and missiles. When we see them in color the bright red glow of the nozzle through which the propelling jet issues is evidence that this orifice or rocket nozzle is one of the most severely stressed parts of the entire missile. The temperature of the flame passing through these nozzles may range from 5000°F to 6000°F. It is believed that fuels are available which would exceed these temperatures if there were means available to permit the use of such fuels. The nozzle must withstand not only the extreme pressures and temperatures of the propelling jet but also the very high velocities which abrade and ablate the surface. Whether there be one or a plurality of these nozzles on the missile the problem is essentially the same—that the speed and range of the vehicle are limited by the ability of these nozzles to meet the severe conditions.

Similar problems of temperature and pressures beyond the range of ordinary experience are found in other aspects of space travel. For example, in the acceleration of vehicles taking off, the leading surfaces are subjected to increasing temperatures as the velocity increases. There is here, however, the fortunate circumstance that the velocity of a taking off vehicle is lowest where the air resistance is highest and attains maximum velocity only in the absence of appreciable air. However, in the case of re-entry, particularly of manned vehicles, the problem of temperature resistance assumes a tremendously important role. In a typical case of re-entry a vehicle traveling at a speed of about 18,000 miles per hour would begin a glide at an elevation of some 75 miles, by taking an angle to the horizontal of only 2°. By the time the vehicle had reached an elevation of 25 miles the surface temperature of the vehicle would be in the vicinity of 4,750°F, and the speed would have increased to some 18,360 miles per hour. If the glide angle should be increased to 3°, temperatures completely destructive would be encountered.

Part I is by H. W. Highriter, Vice President, Director of Development Metals and Fabrication Division, Fansteel Metallurgical Corporation and part II, on page 29, is by R. W. Yancey, Consulting Metallurgist, Metals and Fabrication Division, Fansteel Metallurgical Corporation.

Materials Critical

Materials for construction of these vehicles constitute probably the largest area of uncertainty and difficulty. Not only in power plants but also in skin surfaces as well as in structural members, the ability to withstand both very high temperatures and high stresses is encountered. For example, the materials selected must have high melting points; they must possess strength over a wide temperature range, and they must possess a measure of ductility, at least a lack of brittleness and the ability to resist sudden thermal and mechanical shocks. The materials should be able to resist erosion of high velocity supersonic speeds and they should resist oxidation at high temperatures, or at least be so protected as not to be destroyed by oxidation. Finally, these materials of construction must be such that they can be formed into large sheets, welded or cast, or otherwise wrought to the necessary contours.

So far these requirements have limited the selection of structural materials largely to the metallic field and to what we term the refractory metals. We use the term *refractory* to imply a high melting point, in excess of 2000°C or about 3600°F. Other industries, notably the copper and brass industry, use refractory to define difficulty of working and to some extent that applies also to our metals.

Four refractory metals produced by the Fansteel Metallurgical Corporation are tantalum, columbium, tungsten and molybdenum. They are classified about in the center of the well-known periodic table of the elements. Tantalum and columbium, in the fifth group of the periodic table, are very similar in their chemical and metallurgical properties except in the matter of density, tantalum being very nearly twice as heavy per unit volume as columbium. The other two metals, tungsten and molybdenum, appearing in the sixth group of the periodic table and having chemical and metallurgical properties similar to each other, also have the same relationship to each other in the matter of density as tantalum to columbium, tungsten being very nearly twice as heavy as molybdenum.

In a tabulation of the metallic elements having melting points in excess of 2000°C (3632°F) there will be found ten elements. Arranged in the order of decreasing melting point they are: tungsten, melting point 6152°F; rhenium, 5732°F; tantalum, 5425°F; osmium, 4892°F; molybdenum, 4752°F; iridium, 4449°F; columbium, 4379°F; ruthenium, 4352°F; hafnium, 3866°F, and boron 3812°F. Of these metals, osmium, iridium and ruthenium are precious

metals in short supply and priced out of consideration. Rhenium also is a rare and high priced metal selling for as much as $2,000 a pound. Hafnium is not a plentiful element nor is it high on the list of melting points. That leaves tungsten as our metal of highest melting point, tantalum next, then molybdenum and columbium. Tungsten and tantalum are also quite heavy metals, both being in excess of twice the weight of iron, whereas molybdenum and columbium are more nearly of the same order of magnitude as iron.

Tungsten, in the form of moderately fine wire, is one of our strongest if not the strongest pure element, having a tensile strength in excess of ½ million pounds per square inch. However, this metal must be severely worked in order to develop a fibrous structure to attain this degree of tensile strength. As first made, the material is neither ductile nor readily workable. Molybdenum is more easily formed than tungsten, although it is a rather hard and not too ductile metal. Tantalum and columbium, on the other hand, are quite soft and very readily formed.

Tungsten is really a metal built upon a heroic scale. It is our strongest metal, one of the most dense, one with perhaps the greatest natural hardness and the least workable character. It requires high temperatures to work it into usable form and after such working it is necessary to heat it to approximately 2500°F in order to allow it to recrystallize. After such recrystallization, it has lost most of its ductility.

An unfavorable characteristic of all of these metals is that they are quite readily subject to oxidation and absorption of gases from the atmosphere, rendering them either brittle, as in the case of tantalum and columbium, or causing destructive loss, particularly in the case of molybdenum where the oxide of molybdenum volatilizes at not much over 900°F. Consequently, all of these metals must be protected against atmospheric attack while hot. Much effort has and is being devoted to the development of suitable coatings for these metals at elevated temperatures.

Mention was made earlier that speed range and altitude depend upon flame temperatures. For lower temperatures, nozzles of molybdenum are adequate. However, as performance requirements increase, the flame temperatures become higher than molybdenum can withstand. There are other metals of higher melting point that can be used, such as tantalum. and this is being tried. Our present knowledge, however, indicates that maximum performance will not be had until tungsten nozzles and parts are available.

It is in the tungsten area that Mr. Yancey will discuss some of the work which Fansteel has been doing in an effort to reconcile the great need for tungsten parts with the difficulties of producing such parts from tungsten.

part 2

WITHIN THE LAST few years there has been a tremendous increase in the interest and use of pure tungsten products or alloys containing a high percentage of tungsten. Due to its density it is being used in the atomic energy field for the absorption of radiation from highly radioactive materials. Another major use of tungsten alloys is in the dampening of vibrating parts of high speed aircraft. These high density products are made by cementing tungsten particles together—like gravel in concrete. This process is called powder metallurgy. The mechanical properties of these alloys are dependent mainly on the nature of the cement, and not of the tungsten particles. Melting point, density, high temperature strength, modulus of elasticity of the alloys and other properties are inferior to those of pure tungsten. Also, it is practically impossible to work the powder metallurgy product except by machining.

We have asked ourselves at Fansteel many times, "Why not make these products out of pure tungsten if it is superior?"

The answer is that up to the summer of 1958 nobody knew how to fabricate tungsten in other than relatively simple shapes. Also, the ratio of cost to economical performance did not provide the incentive to develop new manufacturing techniques in wrought tungsten. Emphasis has changed rapidly in recent months and now it is being placed upon performance rather than cost.

The constant pressure to obtain greater reliability and longer life in electronic tubes and controls; to reduce component sizes; to process materials at higher temperatures; to manufacture components and assemblies that will have adequate strength at unbelievable operating temperatures, and to construct the research equipment for the exploration of new high temperature phenomena has made it necessary to develop processes for the fabrication of pure tungsten products. And now it appears that tungsten will assume an important role in rockets and space vehicles.

It is in this area of development that we believe a significant breakthrough has been made.

Suppose the question is asked, "Why is the fabrication of tungsten so exceptional?" For one thing, it is necessary to heat it to temperatures at which stainless steel and some of the super-alloys with which you are familiar would be molten.

The next logical question is, "How do you hold it while working it?" and the answer is, "You don't." That is, you don't hold it very long. The working of tungsten must be done at a high temperature and must be done very quickly.

Once you have done some preliminary working, continued working is less severe, but here you run into another problem—its terrific strength and its tendency to lose ductility as it approaches room temperature—so much so that if a hot tungsten part is put into contact with a cold tool in such a way that it surrounds the tool, the tungsten begins to shrink and the tool begins to expand. The result—a broken tungsten part.

Considering the ductility of tungsten versus temperature we find that as the tungsten cools to a temperature approaching 800°F, it rapidly loses much of its ductility and rapidly gains in strength. This means that tools have to be fabricated from an alloy that has good high temperature strength in itself, and considerable resistance to wear.

Forgings are made in a series of steps or sequences, taking advantage of tungsten's increased ductility as it is subjected to further working. The forging technique may be used for a simple rivet, the target in a new design of X-ray tube, the throat of a rocket nozzle, or any one of a variety of electronic tube components.

Large X-ray targets can be made by pressing tungsten powder into preformed shapes which can then be sintered and forged to acceptable density. There are numerous products that can be fabricated by this method.

Another new development is seamless tungsten tubing produced by hot extrusion. For all we know an extruded tube reduced by 70% of its original area could be used for drawing thinner walled tubing, or it could be hot upset to make a special shape. It could even be cut into slices for flywheels in self winding wrist watches, for electrical contacts, for small gyroscope rotors, or for many

(*Continued on page* 41)

by CAPTAIN E. E. WALLER, AS/SigC

18.201 - 1.778 ↓ 19.500[4]- ^1.432 - 121 - 5.628:

military translingua

(The author is stationed at the United States Army Security Agency, School and Training Center, Hq. Company, 1st Bn., Fort Devens, Mass.)

ONE OF THE fascinating recent developments in linguistics has emerged after several years of research at the University of Iowa. Seven years ago Dr. Erich Funke, Head of Foreign Studies at the State University of Iowa, began work on a method for interlinguistic communication. A practical application of Dr. Funke's method is Military Translingua, which is designed for multilingual military commands and international commercial correspondence.

Since the dawn of history, the military leader has been faced with the problem of precise communication with allies and elements of his command who use different tongues and dialects. The celerity of modern warfare and the need for all the allies that the Free World can muster in these challenging times impinges heavily on the efforts of the soldier to explore every new vehicle that may help him find a meaningful, simple, precise, unclassified method of interlinguistic communication.

The translingua script offers interesting possibilities to alleviate this age-old military problem. It recognizes the validity of the sage advice of Sun Tzu: "He who has a thorough knowledge of his own conditions as the condition of the enemy is sure to win in all battles."

Translingua divides all human knowledge into some 35 numerical categories (for example, 15 denotes "medicine and health," and 26 refers to the "armed forces"), which are, in turn, broken into sub-concepts to make up a basic vocabulary of 25,000 words of a numerical language.

How is this used?

Take the title of this article. Its Teletype equivalent would be: 18.201-1.778:5-19.500:4-1.432:18-121-5.628. Assume that the originator is a West German commander, General Karl von Rhein. Without needing a knowledge of English or any other language used in a NATO command, he has been able, by the use of his German-translingua dictionary, to prepare this translingua numerical sentence from the following German: "Der Feind griff die Stadt überraschend von Süden an." The English-speaking recipient, just the same as a Portuguese, Dutch, Italian or other language group, without leaving the domain of his own language, can simply obtain his own tongue by the use of his translingua-English dictionary (or translingua-Portuguese, translingua-Dutch, etc.), to obtain: "The enemy attacked the city surprisingly from the south."

When dealing with the more exotic languages of the East and the concomitant problems of translation, the use of translingua comes into closer focus, especially in preventing the tyro linguist from making serious mistakes stemming from a lack of precise knowledge of idioms or technical military terminology. Anyone who has heard a story repeated several times readily understands the possibility of distortion when many people are involved. It may seem humorous that "jack up" in Spanish could be literally translated as "to raise with the cat," but the exigencies of the military situation in modern conflict may not give us the luxury of enough well-trained language personnel to prevent a modern version of the Tower of Babel. The following passages may point up the ease of using translingua if a dictionary is available:

You, as an English-speaking recipient, may receive the following sentence from an Arab originator, General Abdullah: 7.1805-6.1000:2-5.400:17-5.625-5.626-5.429:4-6.103:2. The Arabic original of: "Algutru 'lmisrīyu yuksueinu 'zzāwiyata 'shshamālīyata 'shshargīyata min afrīgiyatin," may be rendered into: "The land of Egypt forms the north-east angle of Africa," by learning the simple translingua grammar and by quickly looking up each number, as separated by dashes. Other examples could be given in languages ranging from Spanish to Indonesian and Swedish to Chinese.

Translingua, by itself, is no more safe than ordinary English. Its vocabulary needs more revision for military use. It is no more difficult to use than a telephone directory and its vocabulary numerical equivalents do not change, though they may be added to at any time by new words or new concepts. The following exercise evinces the preciseness of translingua grammar in action:

8.1-1.162-7.312:4 for, "The man drinks water."

8.1-1.162:5-7.312:1 for, "The man drank the water."

8.1-1.162:8-7.312:1 for, "The man will drink the water."

8.1:1-1.162-7.312:4 for, "The men drink the water."

8.1-1.162-2.35-7.312:4 for, "The man drinks cold water."

8.1-5.770-1.162-7.312:4 for, "The man drinks the water today."

8.1-4-1.162-7.312:4 for, "The man does not drink water."

8.1-29-1.11:5-119-31.1-1.162:5-7.312:4 for, "The man who came into the house drank water."

11-41-1.162-30-7.312:4 for, "You can drink this water."

11-4-41-1.162-30-7.312:4 for, "You cannot drink this water."

11-35-41-1.162-30-7.312:1 for, "You can drink this water now."

Note the simple sequence of words and the use of ":1" for the plural concept and ":4" for the direct object.

Research into the nuances of translingua usage and practical applications thereof is continuing at the State University of Iowa (Iowa City) under direction of Dr. Funke. In a day when our Free World allies speak languages ranging from Norwegian to Turkish and Portuguese to Siamese, any meaningful multi-lingual concept becomes useful for considered study. As Bacon has noted, "Knowledge is power."

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center. Information carried by the simplex channels is comprised of multi-channel teletype, voice, facsimile and other data. The microwave system will operate in the 7125 to 8500 mc. range; the tropospheric system, in the 1700 to 2400 mc. band.

MANHATTAN PHYSICAL RESEARCH GROUP, INC. is an independent firm of scientists, physicists, engineers and mathematicians established to help companies with their research programs. Located in New York, MPRG has performed work on inertial guidance and nuclear reactors for industrial clients.

LOCKHEED ELECTRONICS CO. is a new subsidiary formed by Lockheed Aircraft Corp. as a further step in the program to extend its share of government and industrial markets for electronic systems, controls and other devices. The new corporation will include the recently acquired Stavid Engineering, Inc. of Plainfield, N. J., and the Lockheed Electronics and Avionics Div. of Newport Beach, Calif., which will be renamed the Stavid Div. and the Newport Div., respectively.

WESTINGHOUSE ELECTRIC CORP. has designed and built three large amplifiers which will be used to power a research version of the ion space engine now under development by the National Aeronautics and Space Administration. The ion engine, which produces a jet-like thrust by expelling electrical particles at high speed, is believed by NASA researchers to meet the requirements of a propulsion unit suitable for orbiting the earth or for traveling between planets without actually landing. The amplifiers will be used to accelerate electrical particles to extremely high velocities. When these particles are ejected through the engine's exhaust, they will produce a forward thrust in much the same way that chemical fuels provide thrust for rockets.

DAYSTROM, INC. has established a Technical Advisory Committee of five university scientists to keep the company in the forefront of long range research and development on a continuing basis. For its first assignment the committee will review the R&D program of each Daystrom division and assist in coordinating divisional activity.

PACKARD BELL ELECTRONICS CORP. has begun work on the design, development and production of a multi-channel, ground-air-ground radio receiver, under an Air Force contract. The contract specifications call for extremely high RF selectivity, frequency accuracy and stability within one KC throughout the tuning range of 225 mc. to 400 mc. and provision for 3500 channels.

PAGE COMMUNICATIONS ENGINEERS, INC. has established a Telecommunications Directorate which combines within a single corporate entity the responsibility for fundamental systems analysis, network planning and determination of performance criteria. The new directorate consists of two departments. The first of these, Global Systems, will be responsible for ground-to-ground type networks. The second, Spatial Systems, will concentrate on circuits associated with lunar probes, interplanetary communications and satellite relays.

— GENERAL —

ELECTRONIC INDUSTRIES should find 1960 a record breaking year, according to the Business and Defense Service Administration of the Commerce Dept. It is believed that factory sales of equipment and components will reach $10 billion during this year and employment in the industries producing electronic products, which reached record levels in 1959, should increase still further this year.

ELECTRONICS OUTLOOK IN THE 1960's places greater emphasis on electronics detection, guidance, control and communication equipments as a result of anticipated developments in space vehicles, guided missiles, nuclear-powered naval vessels and aircraft, according to a year end statement by J. J. Farrell, General Manager of Heavy Military Electronics Dept., General Electric Co.

THIRD INTERNATIONAL EXHIBITION OF ELECTRONIC COMPONENTS will be held in Paris, February 19-23. The exhibit will feature radio-frequencies aerials, beam aerials and radio-electric frequencies coils, which include tuning circuits system for broadcasting and intermediate frequency transformers for broadcasting. Organized by the National Federation of French Electronics Industries, the exhibit is open only to manufacturers of electronic appliances.

ADVANCED RADAR TRACKING DISPLAY COMPUTER has completed its first 1000 hours of operation at the National Aeronautics and Space Administration's Wallops Island, Va., test range. Developed by Computer Systems, Inc. to operate with all operational radars, the MC-555-A provides calibrated parallax and scale factor controls for all output channels, permitting insertion of plot parallax and use of maximum possible resolution in plotting computed data. NASA personnel are using the resultant plots for vectoring aircraft and for analyzing vehicle trajectories.

(*Continued on page* 35)

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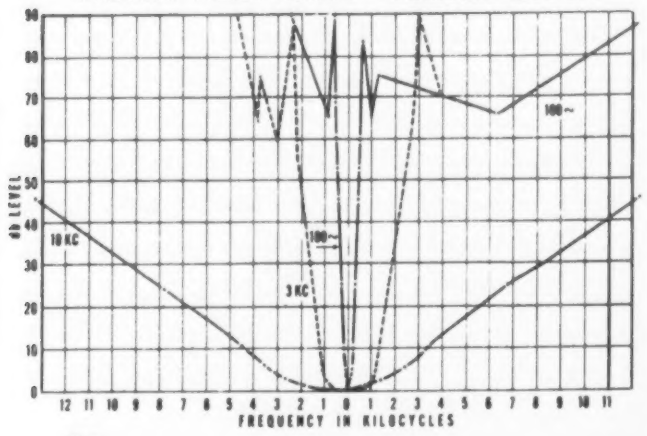

MODEL 2174A

SPECIFICATIONS

MODEL	FREQUENCY RANGE	SELECTIVITY	LEVEL FULL SCALE	ACCURACY	TYPICAL FILTER SELECTIVITY
2171A	**50** Cycles to **6** Kilocycles	30 Cycle or 50 Cycle Filter	−68 to +32dbm	± .5db −80 to +32dbm 300 Cycles to 4 Kilocycles	**30 CYCLE FILTER** 6db— 35 Cycles 60db—250 Cycles
2174A	**300** Cycles to **400** Kilocycles	50 Cycle or 100 Cycle Filter *	−68 to +32dbm	± .5db −80 to +32 dbm. 300 to 400 Kilocycles	**50 CYCLE FILTER** 6db— 60 Cycles 60db—450 Cycles
SPURIOUS RESPONSE: Below 60db LOW INTERMODULATION: Below 60db POWER REQUIREMENTS: 115 V. A.C.—50/60 Cycles. WEIGHT: 28 lbs.					**100 CYCLE FILTER** 6db—140 Cycles 60db—900 Cycles

* Including a wider filter and demodulator for monitoring SSB, AM and FM signals.

Submit your requirements for special deviations from above instruments

A highly selective measuring instrument, utilizing the heterodyne principle with balanced modulation, offers fast and accurate means of making amplitude measurements. High resolution is achieved by means of highly selective crystal filters, with a 50 or 100 cycle filter available for amplitude measurements.*A 3 kilocycle filter with demodulator is provided for monitoring of SSB speech or tone signals.

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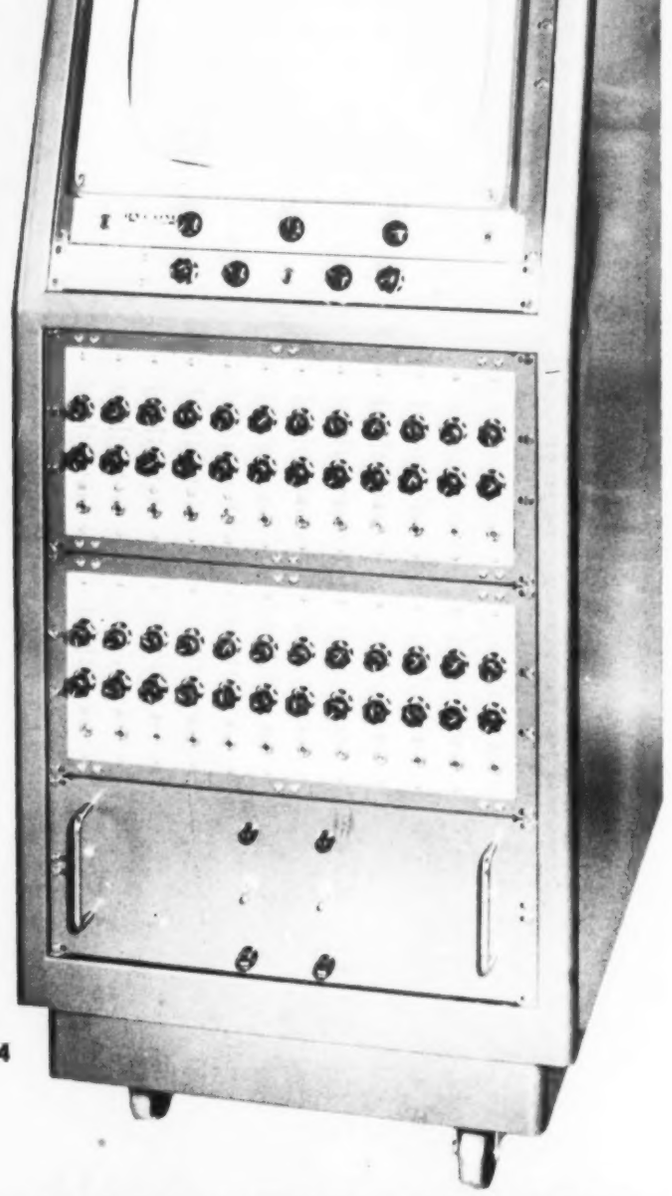
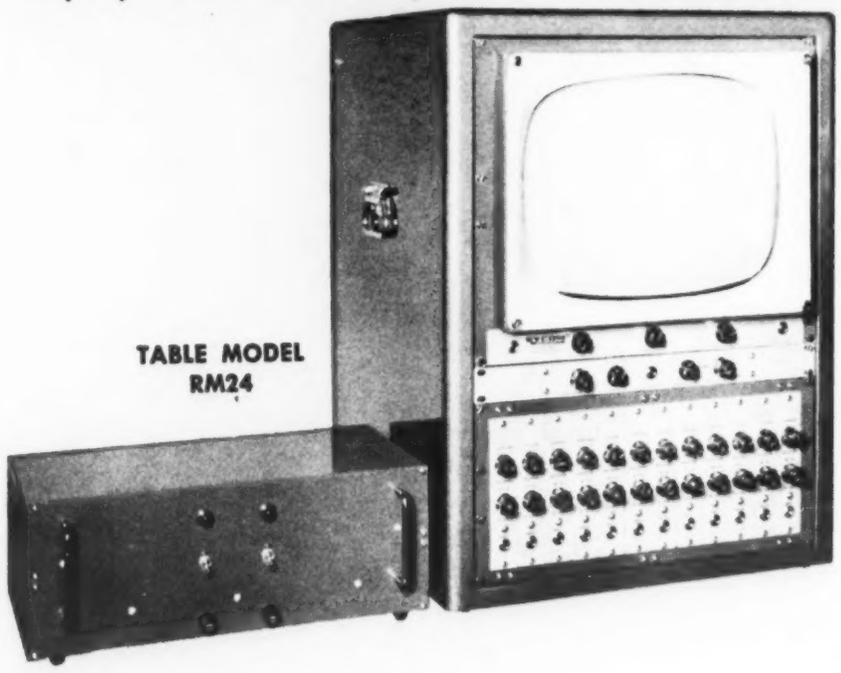


CONSOLE MODEL RM24



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- ANALOG FUNCTION
- STATIC MEASUREMENTS
- BIOLOGICAL WAVEFORMS
- TELEMETERING
- MAGNETIC TAPE-INDICATOR
- DIRECT VISUAL APPLICATIONS

SPECIFICATIONS

SENSITIVITY	INPUT	SWEEP	RESPONSE
10 Millivolts Peak to Peak/inch with Standard Channel Amplifier 2410.	Differential, D. C. Coupled. Input Impedance 2 Megohms—50 Micromicrofarads.	Recurrent or Triggered: Calibrated from 100 Microseconds/Centimeter to 1 Second/Centimeter.	D. C. to 3500 Cycles/Second (10 Dot Resolution for Sine Wave Presentation).

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Signalgram (*Continued from page 32*)

A BRITISH ATOMIC SHIP should be built, according to two British naval architects. Dr. E. C. B. Corbett and E. R. Hawthorne believe that Britain should start building a nuclear freighter for trading with Australia and New Zealand. A ship powered with an "organic moderated reactor," now under development in Britain, could be operating in five or six years, they said.

PHYSICAL SOCIETY'S ANNUAL EXHIBITION IN BRITAIN featured over twenty new instruments. Some of the items exhibited January 18 to 22 in London included: a pressure scanning valve which permits one pressure transducer to sense pressures at a number of points in a system by sequential sampling; a computer digital voltmeter type TM.923 which has a five figure presentation; a precision data amplifier, AA.900 for use in data processing.

GRANTS FOR SCIENCE STUDIES for 143 universities and colleges will total more than $1,300,000 in the E. I. DuPont De Nemours and Company's 1960 program of aid to education. The largest part of the program, $580,000 in grants, will be used to help strengthen the education of future scientists and engineers at the college level. Colleges are free to use the funds in ways they feel will advance most effectively their instruction of the scientific subjects and stimulate interest in them.

AUTOMATIC COMPUTATION is becoming a frequent aid to scientific research, according to a technical report from the National Bureau of Standards. NBS increases the effectiveness of its own scientific program and those of other Government agencies through a computing service which solves problems ranging from the calculation of satellite orbits to the evaluation of molecular models. The computations are performed on a high speed computer and frequently constitute a valuable aid to the development of theory.

ASM METALS DOCUMENTATION SERVICE provides the metal industry with immediate information on any aspect of metals and metals engineering appearing in current world literature. Begun last month after four years of research, the American Society for Metals' automated searching service utilizes the advanced GE-250 Information Searching Selector built by General Electric Co. to index and encode on magnetic tape some 12,000 metal literature abstracts published yearly. The GE-250 then searches these encoded abstracts at the rate of 100,000 per hour and answers general or specific questions on metals.

SUBSTANTIAL INCREASES IN SALES OF SEMICONDUCTORS and sustained high volume production and use of receiving tubes, power tubes and cathode ray tubes are pictured for the electronic components industry in 1960 by L. Berkley Davis, General Manager, Electronic Components Div., General Electric Co. Semiconductor sales will reach $550 million, a 37 percent increase over last year, according to Mr. Davis.

MEDICAL EMERGENCY RADIO SERVICE to provide transmission of messages essential to physicians, hospitals and emergency ambulance services may be created by the Federal Communications Commission, which is presently studying comments on the advisability of such a service. Proposed service allocations would give the radio service 13 frequencies in the 152-162 mc. band and 4 frequencies in the 42-50 mc. band.

HIGH SPEED CAMERA in which a magnetic fluid clutch is used to obtain film speeds of 35 feet per second in less than 1/10 of a second has been patented by a Lehigh University (Bethlehem, Pa.) professor in Fritz Engineering Laboratory after seven years of work. Designed by Ivan J. Taylor, instruments associate at Lehigh, the camera can save time for the research engineer because the camera reaches maximum speed after only one foot of film is used and several film records may be made from a single loading of film.

TIME-DIVISION DATA LINK, a communications system designed to aid in the control of manned and unmanned aircraft, was explained to Air Force officials by Radio Corporation of America personnel at a recent conference. Under an Air Force contract, RCA will supply Data Link equipment for use in the SAGE and BOMARC systems.

CALENDAR OF EVENTS:

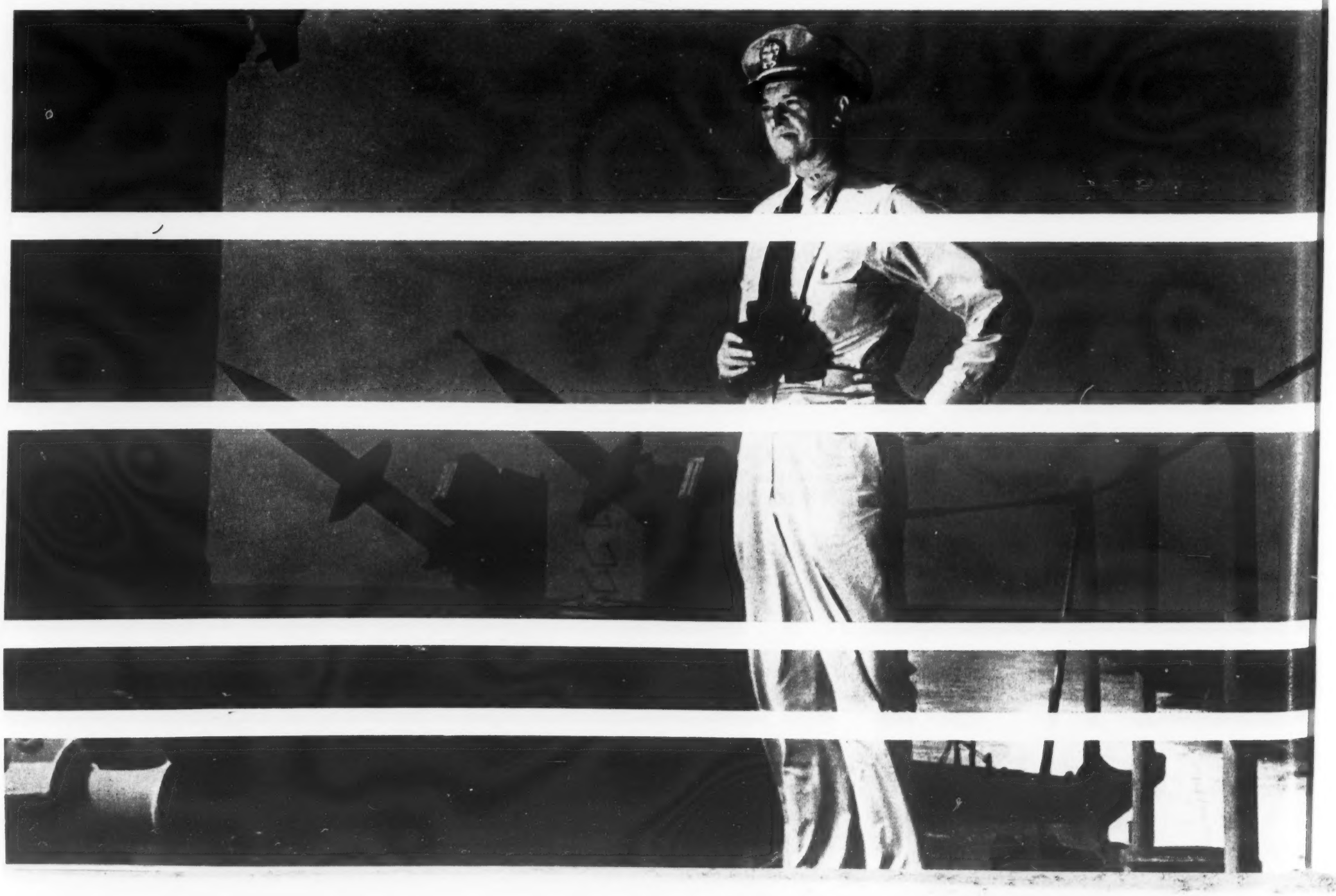
FEBRUARY 10-12: Solid-State Circuits Conference, sponsored by Institute of Radio Engineers-Professional Group on Information theory and the American Institute of Electrical Engineers, University of Pennsylvania, Philadelphia.

FEBRUARY 18-22: 14th National Photographic Show, sponsored by Photographic Manufacturers and Distributors Association, Coliseum, New York City.

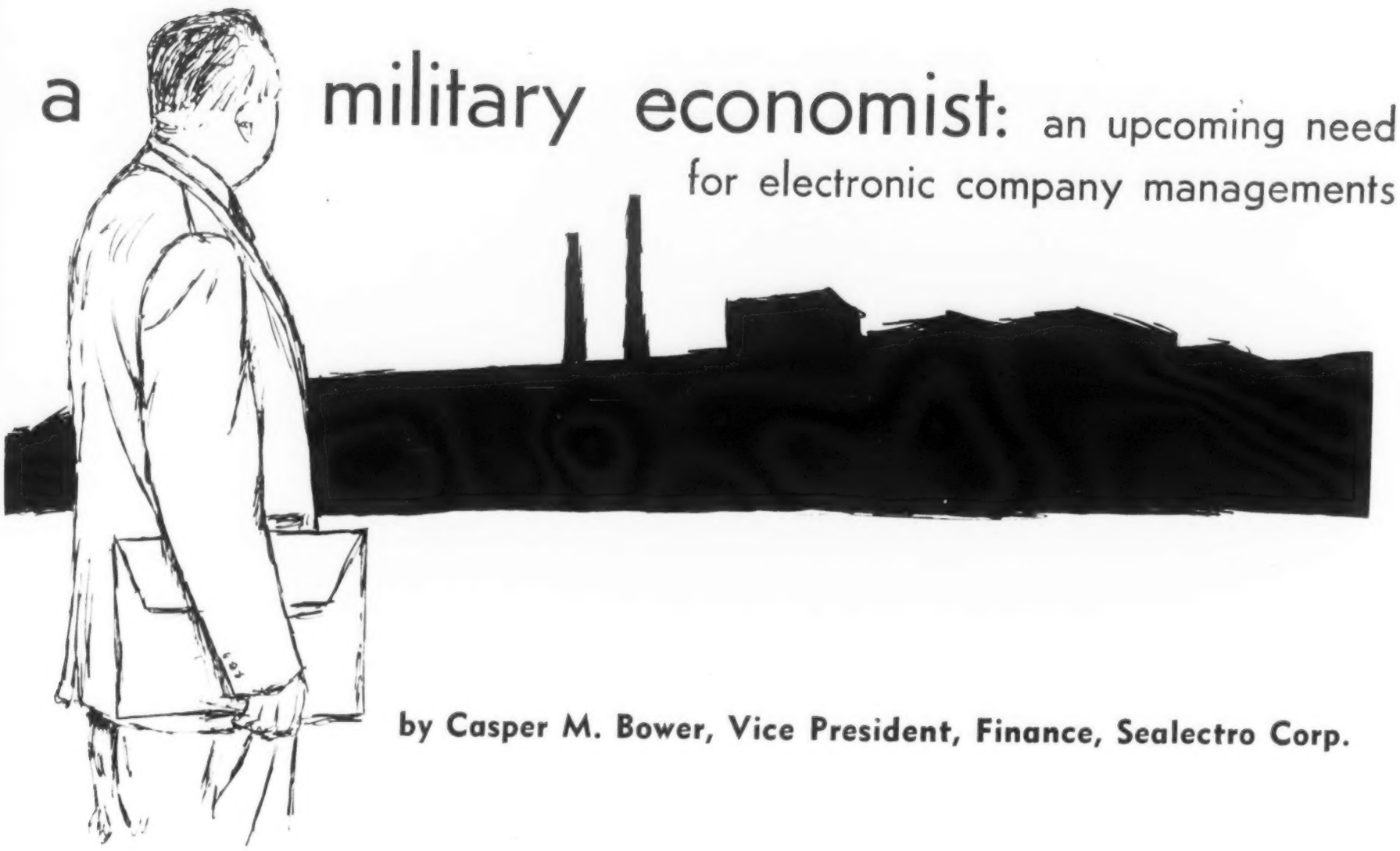
FEBRUARY 21-24: 42nd National Meeting of American Institute of Chemical Engineers, Biltmore Hotel, Atlanta, Ga.

FEBRUARY 29-MARCH 2: Special Electronics Meeting, sponsored by American Management Association, Statler-Hilton Hotel, New York City.

SPECIAL ANNOUNCEMENT: ***Communications pulls the fleet together and in April SIGNAL will pull the Naval Communications story together. Featured among other subjects will be: weapons systems; research and electronics; communications in fleet operations; antennas; navigation; specifications; frequency spectrum; communications and electronics in space; international aspects; and Marine Corps communications.***



a military economist: an upcoming need for electronic company managements



by Casper M. Bower, Vice President, Finance, Sealectro Corp.

MY SUBJECT deals with the very provocative topics of defense appropriations, economics and, of course, electronic companies. So without further ado, I will plunge into this arena of dispute.

The peacetime defense industry was a mere infant just a few years ago. Today, it is a colossus. It is big in size and its circuits of influence fan out in many directions. It has, unquestionably, a heavy impact on some of the economic forces which mold the health of the nation's business.

Some 1,500 plants and about a million men and women are busily researching and manufacturing myriad electronic products for the ultimate civilian and military markets. But of considerable consequence to the state of the nation's business, and to these thousands of electronic firms, are the many billions of dollars spent annually for militant and advanced scientific purposes on earth and in outer space.

These expenditures are, and will continue to be heavily underwritten by annual government appropriations. Pending Congressional approval, the debates and appropriations, particularly for future specific amounts, can, and apparently do, generate doubts about and even shifts in the conditions of over-all business.

As such, the new fiscal stature of what we may presume to call the "permanent defense industry," coupled with erratic economic side effects which seemingly stem from sudden contract cancellations and material revisions in appropriated dollar volume, should be evaluated constantly by all defense equipment suppliers. And it might behoove other industrial managements to keep their probes on this sensitive area of government spending.

In the light of these remarks, I offer defense managements and others as well, these three postulations:

One—that the year by year amounts of defense expenditures may become a sensitive barometer; its rise and fall influencing the purchasing moods of the public and business men alike, and, the varying amounts of defense expenditures will, in my judgment, influence industrial stock prices.

As you undoubtedly know, some prominent economists include security price averages among the eight lead bellwethers of business changes. There is evidence too, as I discuss later, that a sustained reversal in the direction of security prices, induced by Congressional debates, or the actual contraction or expansion in defense appropriations, can trigger consumer chain reactions which affect all types of business, other than military. In fact life cyclical movement of security prices appears to perform a dual role of forecasting and influencing business activity.

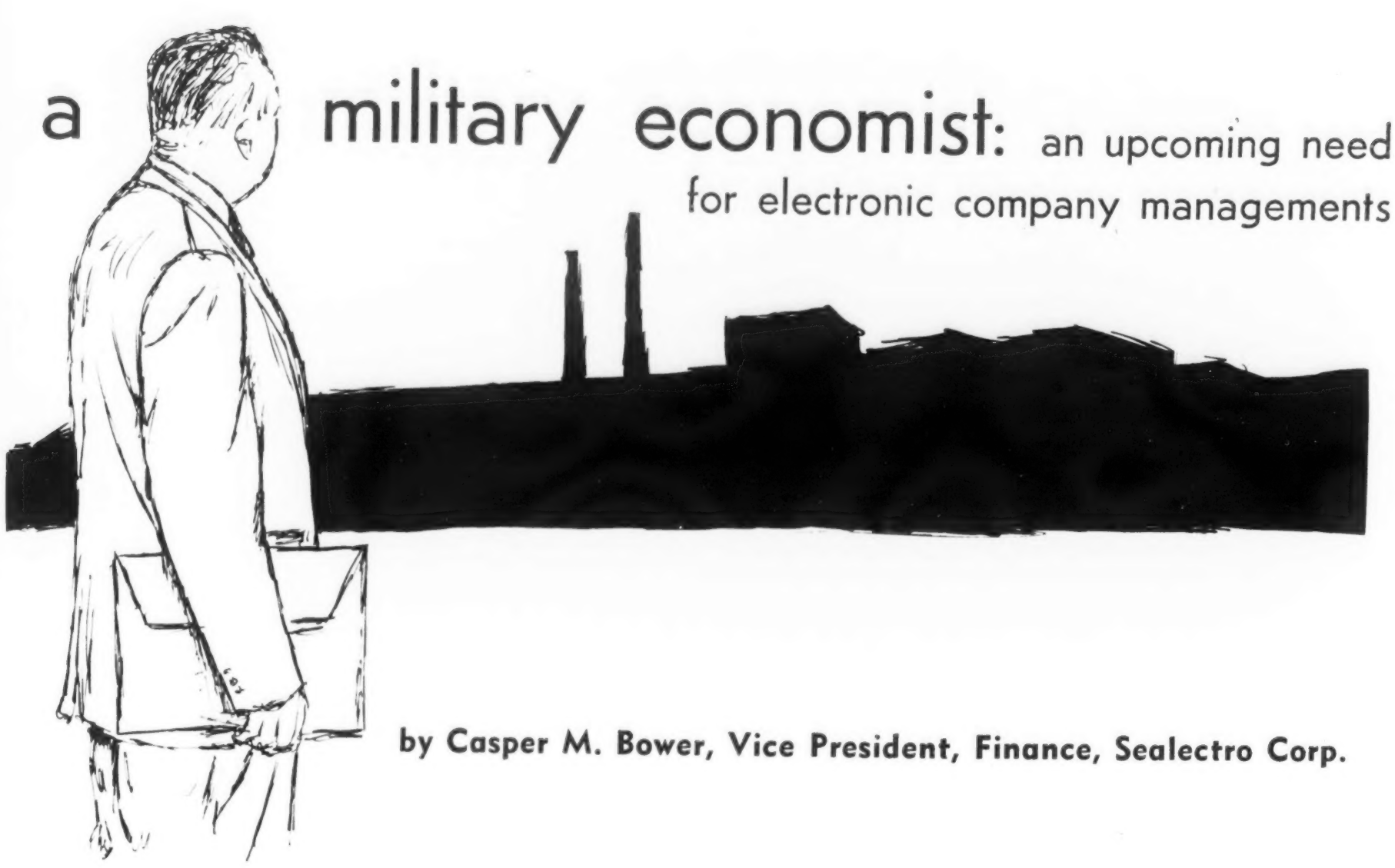
Two—that whether or not a summit meeting as such is ultimately held, the amount of annual defense appropriations will continue to be a political football kicked by the lobbies for or against expanding defense needs. The public, and many company managements, will be hard pressed to assess the validity of the conflicting issues in the face of bombast from protagonists on either end, and the appeals from neutrals in the middle.

Three—that electronic companies, particularly those feeding almost completely from the trough of defense money should add a military economist to their managerial staffs. A few pioneering firms already have recognized this need and have hired such an economist.

Here is how his job description

SPECIAL ANNOUNCEMENT: ***Communications pulls the fleet together and in April SIGNAL will pull the Naval Communications story together. Featured among other subjects will be: weapons systems; research and electronics; communications in fleet operations; antennas; navigation; specifications; frequency spectrum; communications and electronics in space; international aspects; and Marine Corps communications.***

a military economist: an upcoming need for electronic company managements



by Casper M. Bower, Vice President, Finance, Sealectro Corp.

MY SUBJECT deals with the very provocative topics of defense appropriations, economics and, of course, electronic companies. So without further ado, I will plunge into this arena of dispute.

The peacetime defense industry was a mere infant just a few years ago. Today, it is a colossus. It is big in size and its circuits of influence fan out in many directions. It has, unquestionably, a heavy impact on some of the economic forces which mold the health of the nation's business.

Some 4,500 plants and about a million men and women are busily researching and manufacturing myriad electronic products for the ultimate civilian and military markets. But of considerable consequence to the state of the nation's business, and to these thousands of electronic firms, are the many billions of dollars spent annually for militant and advanced scientific purposes on earth and in outer space.

These expenditures are, and will continue to be heavily underwritten by annual government appropriations. Pending Congressional approval, the debates and appropriations, particularly for future specific amounts, can, and apparently do, generate doubts about and even shifts in the conditions of over-all business.

As such, the new fiscal stature of what we may presume to call the "permanent defense industry," coupled with erratic economic side effects which seemingly stem from sudden contract cancellations and material revisions in appropriated dollar volume, should be evaluated constantly by all defense equipment suppliers. And it might behoove other industrial managements to keep their probes on this sensitive area of government spending.

In the light of these remarks, I offer defense managements and others as well, these three postulations:

One—that the year by year amounts of defense expenditures may become a sensitive barometer; its rise and fall influencing the purchasing moods of the public and business men alike, and, the varying amounts of defense expenditures will, in my judgment, influence industrial stock prices.

As you undoubtedly know, some prominent economists include security price averages among the eight lead bellwethers of business changes. There is evidence too, as I discuss later, that a sustained reversal in the direction of security prices, induced by Congressional debates, or the actual contraction or expansion in defense appropriations, can trigger consumer chain reactions which affect all types of business, other than military. In fact life cyclical movement of security prices appears to perform a dual role of forecasting and influencing business activity.

Two—that whether or not a summit meeting as such is ultimately held, the amount of annual defense appropriations will continue to be a political football kicked by the lobbies for or against expanding defense needs. The public, and many company managements, will be hard pressed to assess the validity of the conflicting issues in the face of bombast from protagonists on either end, and the appeals from neutrals in the middle.

Three—that electronic companies, particularly those feeding almost completely from the trough of defense money should add a military economist to their managerial staffs. A few pioneering firms already have recognized this need and have hired such an economist.

Here is how his job description

might read: His military function would be to separate fact from fiction in the muddy stream of domestic and foreign propaganda calculated to influence the nation's program for national and international security.

This need was highlighted recently by conflicting views regarding the future course of defense spending which may follow the Eisenhower-Khrushchev meetings. For example, on August 10, 1959, a leading electronic weekly newspaper summarized its canvass of the electronics industry's sentiment about the outcome of these meetings. It observed, "Industry Seen Unaffected by Ike-Khrushchev Visits."

By contrast, the *Wall Street Journal* on August 20, 1959, commented as follows, "Administration Expects Ike-Khrushchev Talks to Help Curb Outlays."

An economist could assist his management in many ways. One important function, and extremely timely now, would be to help steer corporate policy safely through the shoals of what I term "electronic euphoria." This way of economic life seemingly has enveloped many unseasoned electronic company managements who are inclined to believe that defense funds are a one-way street going upwards only.

This military economist should evaluate the effects of expanded or contracted defense funds on over-all business activity. And, in the light of the unexpected business recession which followed the Government's 1957 defense economy moves, about which I later present some provocative data, this contribution to management will be vital. He should also provide financial, marketing and other functions essential to corporate health and growth.

An economist's tool crib for business forecasting includes index numbers, seasonally adjusted or weighted averages, dollars expended for goods and services and many others. However, all these tools fall considerably short of providing bases for precise conclusions because of two vital factors:

(1) The long time-lag required to collect, collate and interpret these data, and, (2) and, likely the most important, the imponderables of human behavior.

Vast sums are spent annually by the Department of Commerce, the Federal Reserve Banks, the National Banks and many public and private agencies in exhaustive efforts to forecast future business activity.

The economists for these groups peer ahead by looking backwards to study past storms and blue skies as pictured by these assorted indexes.

Yet, to date, no agency, public or private, has constructed an index or combination of indexes which can presage with any satisfactory degree of accuracy, when or why the capricious fountainhead of all business—namely, human buying behaviour—will alter its course.

Recently, for example, one Federal Reserve Board Bank, after devoting hundreds of words to the near-term business outlook, concluded by observing with restrained frustration: "It is difficult to predict what the consumer will do next week, next month, or next year."

Another nationwide statistical service used by important banking and brokerage firms commented on this point by similarly stating that *half the increase* in the 1949-57 bull market was "due to improvement in intangibles including the 'feelings of investors'."

Importance of Consumer Mood

The economic force exerted on industry by this fickleness of public sentiment and moods as measured by consumer purchases is enormous. And, the importance of these consumer mood swings on the volume of the nation's business is of major economic significance.

As consumers, we buy and use almost two-thirds of the current estimated 484 billions of gross national product (GNP)—which is the dollar value of the nation's output for goods and services. And the collective consumer mood—on which this two-thirds of all purchases depends—is like an impenetrable fog. It is unyielding to a clearly chartered business forecast.

The other important one-third of GNP comprises expenditures by government and all types of business for such activities as new plants, inventories, road construction and spending for local and national defense.

I suggest here that national defense expenditures which accounted for a minor 8% or so of the estimated 1959 GNP influence *substantially* the buy-or-not-to-buy psychology of the public and business men, too. As such, defense dollars may become a tail that helps to wag the dog of our economy.

The linkage I foresee is the fact that within the past three years a significant public movement has, and is still occurring, which economists have not yet gauged or, perhaps, even added to their analytical tools. Yet, in my judgment, it may provide a stethoscopic reading of consumer mood sensitivity heretofore only casually considered.

I refer to the sharp and expanding increase in the number of individuals who, for the first time, have become shareholders in American industry. The New York Stock Exchange recently released these data on this subject: In 1959 *almost 12.5 million individuals* owned shares in industry—an all time high. This 1959 total stockholding group represented a gain of 45% over the 1956 total of 8.6 millions, and 92% over the 1952 totals of 6.5 millions.

These millions of people are now acutely aware of and sensitive to stock averages, earnings reports, dividend rates, government deficits and surpluses. Most likely too, they are taking a much keener interest than ever before in the annual defense discussions and final Congressional appropriations.

A thought-provoking item in the New York Stock Exchange's shareholder census was that the average annual household income of approximately 47% of these new millions of stockholders was about $6,900. These shareholders, as you can judge, are not capitalists by any stretch of the imagination, particularly when you consider rising living costs and the sharp 23% increase of consumer installment debt since 1956 which must be repaid or provided for from the weekly pay check.

Thus, in the brief three years from 1956 to 1959, several million individuals have been initiated to the exciting exhilaration, of easily-made capital gain or, the mental depression of ill-afforded capital loss.

As shareholders, this group cannot help but read or listen avidly to all news which contributes mystically to the ups and downs in the market value of their small nest eggs. In this way, a broad "news-sensitive" buying group, representing perhaps some 15-20% of the average family unit population of the country, now contributes its collective unpredictable buying habits to the nation's economy further influenced by security price gyrations.

Apart from stock market talk, probably the most discussed household subject at every economic level today is our cold war relations with the Russians and the collateral issues of defense expenditures. As we well know, these issues are being discussed—and acted upon—not only in households, but also in Congress and the White House.

Geographic, sectional and political pressures for increased or static appropriations are likely to continue unabated should a summit meeting, however obliquely, point to a so-called co-existence program.

In this climate, and recalling the business anguish of the 1957 defense economy moves, there are probably only a few Congressmen and business leaders who care to plead the fiscal and economic causes for sound defense appropriation administration.

When these courageous voices do speak out, they argue that a permanent peacetime defense program, elevated above the level of political interference, would likely yield as much unit numbers, if not more, with substantially fewer dollars, than are produced under the present national security program.

But, it is likely that great pressures for downward revision of defense fund will be exerted by some groups if the post-summit meeting, as I said, even hints at a substitution of peaceful co-existence to replace the past 10 years of cold war between us and the Russians.

In this vein, let me modestly call your attention to the fact that I have personally been branded by the Russian newspaper, *Pravda*, as being among, "money-grabbing businessmen . . . and . . . cold war inspirers." The reason for this personal attack upon me was occasioned by an article I wrote which was published in the June 5, 1959, issue of McGraw-Hill's *Electronics* entitled "What If Peace Breaks Out?"

Though they quoted me out of context, and paraphrased my words, here is what *Pravda's* editors said of how I approached the Geneva Conference and the forthcoming summit meeting. Please bear in mind, this article appeared in the magazine before hints of a possible meeting were leaked to the public. "The likelihood of Khrushchev meeting Eisenhower seems quite definite. It will probably result in propaganda with the objective of minimizing the importance of a military approach to problems. . . . This will particularly affect supplies of missiles with warheads and other specific weapons."

The Russians continue, "What will happen if peace breaks out tomorrow? The exceedingly high electronic share quotations may easily drop. The lessening of tension will mean 'debacle'." They conclude, "Not everyone puts it so bluntly in the press as the New York businessman."

My point still is, the Russians notwithstanding, that defense spending has become woven into the warp and woof of our economy. Pull out a few threads of that fabric and there is severe dislocation.

The nationwide recession and unemployment of electronic technicians and others which followed the abortive Spring 1957 defense retrenchment program is probably still acrid in the minds of Congressmen, managers and employees of companies who survive on defense funds. Particularly hard-hit, too, by this unemployment were businesses in small cities and towns which sprang up from the seeds of defense dollars.

Defense and National Economy

A flashback to the situation in the Spring of 1957 can show us the new importance and manner by which actual variations in peacetime defense spending can and did affect the nation's economy. No less an authority than the Government's Department of Commerce in its U. S. Income and Outgo supplement to the Survey of Current Business observed, that government decisions in Spring 1957 to ease budgetry pressures by cutting back the future rate of Federal purchasing, *including defense spending*, was among the depressing influences on the 1957 decline.

The response of the stock market, or perhaps to put it more aptly, the public's attitude or measurable reaction toward the five month period from the start of defense economy to the announcement that defense spending would be resumed is most revealing.

You recall I suggested previously that the movement of industrial stock averages, in addition to its acceptance as a "lead" business barometer is now, because of wider public stock ownership, a powerful influencer of business tempo.

Here is an abridged history of stock averages and business conditions following the Spring retrenchment program to the October decision to renew spending. First let us take a look at the stock averages.

In June 1957, the Standard & Poor's measurement of industrial stock averages was 47.55. By the end of July, they had risen to the year's peak of 48.51.

About this time, implications of defense economy moves, including progress payment stretch-outs were receiving wide scale publicity over radio, television and newspapers, as were the rising level of sectional unemployment and other side-effects.

These mass communications media reach practically into every financial and social segment of our population structure. And by the end of August, 1957, just one month after security price reached the high of the year, the industrial stock averages dropped 6% to 45.84.

Now, and only because it emphasizes the complexities of business forecasting, and because no other index had shown any signs of significant erosion, and finally, because it spotlights the business influencing potency of the stock averages, I quote from a September 1957 issue of an economic bulletin which offered these following profound forecasts as to the business outlook ahead in light of this 6% drop: "Of more tangible importance to the market, however, have been some positive signs from business. These keep pointing to comparative stability ahead, not a recession."

This bulletin continued: "Over the past months or so, the stock market's weakness was in part due to cuts in defense appropriations and arms orders. Russia's announcement of an ICBM may be another propaganda lie . . . The unsatisfactory behavior of the stock market in recent weeks is not traceable to cracks or crumbling within the economy. The business structure is not shaky. Its condition does not justify serious fears on the part of investors."

This statistical organization was not alone in its bullish views on the likely course of business in the face of stock market warnings to the contrary.

A former chairman of the President's Council of Economic Advisors was quoted on the business outlook at that time as follows: "There is no financial house of cards under the business situation."

Mind you, these sanguine business activity predictions were offered in September 1957, just one month after the 6% decline took place in the stock averages.

The stock market however, reflecting a mosaic of public mood, sentiment and suspicion ignored these and other optimistic forecasts. Share values kept declining sharply until practically October 1957. Then the selling wave stopped.

This was the month, coincidentally, that Russia flung Sputnik I into outer space. And the Administration needled by Russia's unexpected promotion to the head of the missile class, publicly announced its plans to renew its defense spending.

Actually, spending resumption did not take place until about April 1958.

(*Continued on page* 40)

Command Guidance for Ballistic Missiles

(*Continued from page* 13)

Figure 8. Launched from Cape Canaveral, the missile was boosted by the Thor 150,000-pound thrust engine, after which the second stage continued to propel the vehicle. Guidance begins shortly after second stage ignition, and steers the missile to meet the correct conditions of position and velocity for a free flight to a point southwest of Ascension Island in the Atlantic Ocean. When the correct conditions are met a command is sent to shut off the rocket motors.

An interesting and valuable by-product of command guidance is the ability to predict impact. After motor cut-off the radar continues to track the vehicle in free flight and determines the velocity. With this information the computer predicts the actual impact point before the missile has completed its flight. This greatly facilitates recovery, in cases where the missile does not perform as directed.

In concluding this presentation I should like to summarize some of the attributes of the Command Guidance System.

• *Simplicity*

The Command Guidance System keeps the complex equipment on the ground in a favorable environment. The expendable missile-borne equipment is simple, light in weight, and low in power drain. The simplicity plays an important reliability role. as well as making possible a maximum missile payload. I might add it also saves money.

• *Control*

For either ballistic missiles or space vehicles, it is desirable to have positive control over the missile at the ground installation during the guided portion of flight. This permits the control operator to monitor performance and abort the missile in a safe condition in case of missile malfunction.

• *Prediction*

The Command Guidance System can be used to track the missile for a period after thrust termination. This information can be checked to predict the probable success of the mission before its completion. The desirability of this feature for intercontinental missiles is quite obvious. It is also desirable for space vehicles, since it permits the results of the flight to be known in advance.

• *Versatility*

I have mentioned previously the adaptation of this guidance system to the Thor-Able re-entry test vehicle program. Other examples of its versatility are represented by its use in the Navy's Transit satellite program under the auspices of the Advanced Research Projects Agency and in the Delta series of satellites and space probes for the National Aeronautics and Space Administration.

The ability to quickly select among several trajectories is very attractive for certain space missions where launching time is critical. Thus, it would be possible to store several lunar trajectories, each appropriate to a particular launching time. A short "hold" which might occur during count-down could then be compensated by selecting the trajectory appropriate to the new time of launch.

• *Reliability*

Reliability is certainly among one of the more important objectives of the missile and space program. I can give you some indication of where we stand with this command guidance system. In the Thor-Able series of seven missiles, and in the ARPA Transit satellite, there have been no failures of the guidance system.

In over 1,000 hours of operation the ground guidance station, radar and computer, have achieved a reliability greater than the advertised purity of Ivory Soap.

• *Accuracy*

Accuracy is, of course, one of the prime objectives of any guidance system. I have described briefly how it is achieved in this system. Unfortunately, security does not permit me to tell you the results obtained. All I can say is that performance has exceeded original expectations.

Sometimes I am asked how accurately we could guide a missile to a selected impact point on the moon. Of course, the formula for a successful lunar mission involves not only guidance but the missile itself. It reminds me somewhat of Paladin's recipe for tiger soup which starts out, "First you have to catch the tiger."

It turns out that tigers are more plentiful in some countries than in others. But if we can "catch our tiger"—and I am confident we will—then I am optimistic about guidance accuracy. In this instance I will not hide behind the cloak of security. Instead I will heed the sage advice of one of our retired Vice Presidents. who admonished, "Let's not brag about our *future* accomplishments."

A Military Economist

(*Continued from page* 39)

Now to the performance of business following these September auguries of continued good health. You all know the answer, but let me give a thumbnail sketch of it again.

Obviously influenced by shrinking security price values kicked off by the August decline, the steepest of the post war recessions was gathering momentum which would not be fully spent until at least April of the following year.

Here are some of the barometric readings for this period: (1) Gross national product lost $19.8 billions in six months. (2) Inventories accumulating at an annual rate of $2.2 billions shrunk by almost $5.5 billions for the year. (3) The Federal Reserve Board Index of Industrial Production slid from the September rate of 144 to an April 1958 low of 128. (4) Corporate spending for new plant and equipment dropped from a July-September 1957 rate of almost $38 billions to July-September 1958 rate of $29 billions. (5) Corporate earnings which had been swollen by peak activity for the first six to nine months of 1957 had begun to ebb.

This then was the aftermath of the broadened public's views of the economic impact of contracted defense spending transferred to security price selling which, in turn, unsettled corporate managements opinions and convictions about the health of forthcoming business.

Thus, within three months from the general date of defense economy, using May 1957 as the genesis, the public took to its collective economic heels and within two months thereafter business men, taking the cue from the public's likely change in attitude or buying sentiment, began to retrench in the various ways possible to them.

Meanwhile, as I stated, stock averages for all practical purposes arrested their decline in October. Thereafter, and until December 1957, a month in which tax selling is always an influencing factor, losses were minimal. In fact, industrial stock averages receded only 1% from October to December whereas the loss from the July peak to the October low was 15%.

Thus to summarize the downward

phase of the past recession, it appears the public arrested its hysterical and infectious selling when assurances were made that defense spending was to be resumed.

This action appears to lend credence to the view that the stock market today, because of the greater numbers of individuals who are becoming shareholders probably mirrors more swiftly and more accurately public mood and sentiment than ever before.

These millions of new shareholders are not generally well-informed as to the intricacies of economics—a science designed to measure their mass or collective behavior—and are well likely to react to propaganda psychology with such force and vigor as to change the upward or downward course of business—contrary to expectations of the sagest of "economists."

Not to be overlooked in this appraisal are the stockholder managers of business—large and small. Their business requirement buying moods can be just as much influenced by unanticipated changes in stock market patterns as are those of the low and medium income wage earning stockholders.

And it is more than likely that some of their company decisions to spend or not to spend for new plant construction, inventories and other daily activities involving expenditures of company money are shaped by their personal reactions to unforeseen major stock price changes. The over-all fulfillment of these business requirements represents a significant portion of gross national product and, as such, plays a leading role in what will be the health of the nation's economy.

So much for the recession, one of its principal causes, and the economic influence of increasing numbers of shareholders who, as they buy and sell securities become an integral part of an index number and, concurrently, shape the pattern of business.

While the foregoing observations are essentially empirical, it is well to review the security price trends and the business events which followed the Government's October 1957 announcement to resume defense spending.

Within two to three months—in fact—starting with the second day of January 1958, industrial stock averages began a steady month by month march upward. This climb contradicted those who foresaw lower security prices, in that business activity really hit the skids during the first quarter of 1958.

Many economists early in mid-year proposed that the business recovery, when it occurred, would take the form of a saucer—that is, level off and remain static at the low level. Thereafter, recovery upward would be slow and gradual. As we now know, following the low point about May-June of 1958, the patient recovered rapidly and robustly, contrary to the predictions of only a slow return to health.

Today, we are faced with an economic and defense picture seemingly a facsimile of that which obtained in 1957. Business is or was at an all time high level. Industrial stock prices hit an all time high on August 3rd; they dropped 3.4% following the Ike-Khrushchev announcements of a joint meeting and defense appropriations may be subjected to major shifts in weaponry emphasis and even realistic pruning. In fact, the *New York Times*, October 11, 1959, said: "The most stringent and austere defense budget since the end of the Korean war confronts the armed services in the next fiscal year, which begins July 1, 1960."

The answer to the general business picture ahead, in the light of the confused defense and national security program, coupled with other disturbing evidences of deep-seated industrial discontent may very well lie within the area of public sentiment and psychology.

The corporate need for economic and military guidance in this present welter of confusion is self-evident.

Refractory Metals (Part II)

(*Continued from page 29*)

electronic tube components.

The process of deep drawing tungsten, to our knowledge, has never been done prior to the last few months. In expanding the limits of fabrication to this extent, an endless stream of component parts for a variety of uses can be imagined. For instance, deep-drawn tungsten boats make it possible to fire electronic tube components to higher temperatures so that better tubes can be manufactured. It opens up the possibility of designing continuous metal evaporating equipment which in turn will reduce processing costs. Advanced design engineers may now consider the deep drawing of other tungsten sheet metal parts, such as vector control devices for missiles and rockets.

Deep drawing and machining can extend the use of pure tungsten for gyroscope rotors. With about 20% increase in density over the tungsten alloys now being used, the drawn rotor may make it possible to decrease the size of gyro-controls and yet retain their operational integrity. Also, from the standpoint of reliability as a function of thermal expansion, the wrought tungsten rotor will have no equal. Tungsten has the lowest coefficient of thermal expansion of any of the metals used in rotor construction.

A hollow unit composed of two drawn tungsten cups brazed together with gold, about the size of a potato, has an interesting possibility. The eye of the potato is actually a hole drilled in the bottom of one of the cups prior to assembly. The little potato was concocted to suggest its use as a radioisotope container. In the January 24, 1959 issue of *Chemical Week* a 5 pound atomic power plant called SNAP III is described. This article describes how the decay of a Polonium 210 isotope creates enough heat energy that it can be collected by thermocouples to produce a power output of 5 watts. The tungsten "potato" assembly might well be a casing for such a power package. Incidentally this 5 pound unit is equivalent to 1450 pounds of conventional batteries, according to the article.

Other drawn cups have been made to show the variations in material thickness that may be drawn and the depth of draw for these thicknesses of stock.

Probably the most exciting part of the tungsten fabrication development program is the fabrication of rolled tungsten plate or sheet by spinning. The ability to fabricate tungsten by this method could very well have far-reaching implications in our race for space. In this, I believe that we have broken through one of the most difficult bastions in the fabrication barrier. Entirely aside from other possible applications of spun tungsten articles in new product designs, our chief interest and most important objective in continued development is in the field of rocket nozzles, and possibly other articles such as re-entry nose cones.

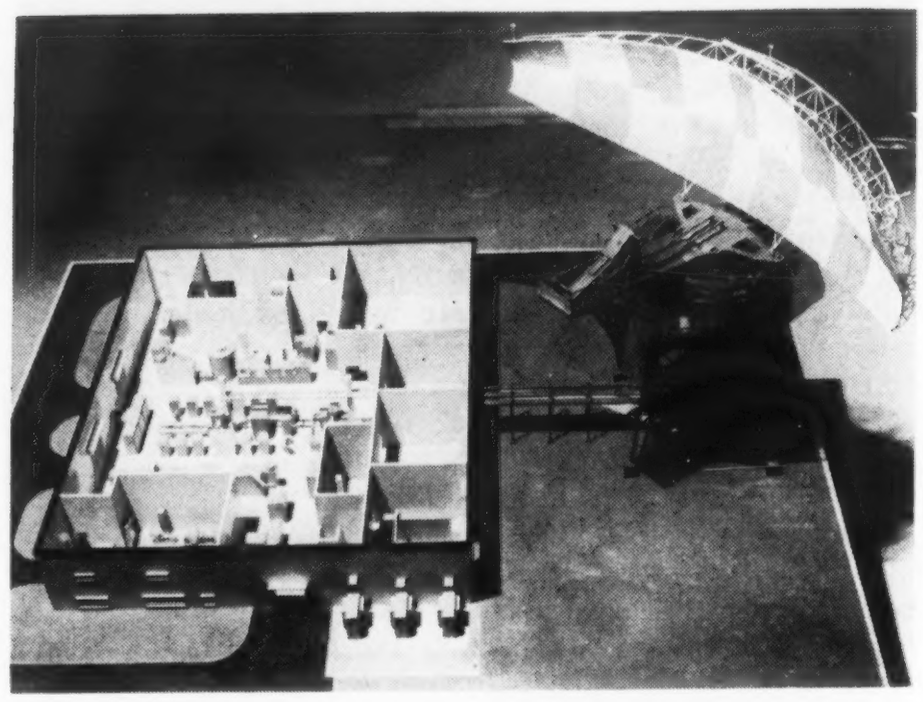
As the burning temperature of rocket propellants increases, the need for higher temperature materials fabricated into many new shapes will have to be satisfied by metals like tungsten.

There is much more development to be done. In demonstrating that tungsten can be fabricated into these products, we believe that we have crossed a new frontier.

AN/FPS—24

search radar for defense

by S. E. HOOD
Signal Staff



Model of prototype AN/FPS-24 Search Radar. Over-all system operation and maintenance controlled from centrally located consoles. Designed and developed for Air Force by GE's Heavy Military Electronics Dept., Syracuse, N.Y., in cooperation with Rome Air Development Center, Griffiss AFB, Rome, N. Y.

THE TERM RADAR is an acronym for *Ra*dio *D*etection *a*nd *R*anging. By the transmission of beamed high-power pulsed signals (radio waves) against reflective targets, this system receives the reflected signals, presents the data on a dial or cathode-ray display and enables the viewer to determine the range of the target by noting the time interval between the transmission of the energy and the reception of the reflected energy.

Practical application of the principle of radar first occurred in 1924 when radio waves were used to determine the height of the ionosphere. In World War II radar found military use during the Battle of Britain. As a military device, its significance is vast. Radar has found military use in air navigation and air traffic control, in altitude measurement, in reconnaissance and mapping, in bombing and homing and in storm detection. Its principal military use, however, is in the detection and location of aircraft and surface ships. It is in this aspect of its significance that radar serves as a tactical warning device to our national defense policy of deterrence. In the event that the United States is unsuccessful in deterring an enemy attack our only chance for survival remains in our capability to repel and effectively counter the attack. To do this we must be able to detect an incoming attack.

Supersonic aircraft and the ICBM as possible attack weapons against us have imposed great demands upon this country to improve radar systems to much higher degrees of accuracy and range.

General Curtis E. LeMay in his keynote luncheon address before the AFCEA Convention held in June of 1959, stated, "We have already established an elaborate network to provide tactical warning, which would ordinarily be notification of an incoming attack. Our warning network against manned jet aircraft and air breathing missiles is practically complete at this time. It consists of our Distant Early Warning (DEW) Line, which runs across the northern fringe of the North American continent—with extensions continuing on to join the NATO system in the East and as far as Midway Island on the Pacific side—plus the Mid-Canada Line and the Pine Tree Line. Other North American radars, early warning picket ships, airborne early warning and control aircraft and Texas Towers complete this system—a vast and intricate network whose optimum effectiveness depends upon rapid and reliable communications.

"The coming of intercontinental ballistic missiles makes our warning and defense problems even more complex. The most obvious impact is the drastically reduced warning which will be available to us in case of a missile attack. Three Ballistic Missile Early Warning Sites (BMEWS) are presently programmed, and one is already under construction. The purpose of these sites is to give this country as much warning as possible of a missile attack. This warning will be 15 or 20 minutes at best. When minutes spell the difference between life or death of a nation, every second—in fact, every micro-second—counts. Again, communications is the key, and again, it must be accurate, rapid and reliable—there is absolutely no margin for error."

The AN/FPS-24 is the latest advanced, high-power search radar to be evaluated by the Defense Department. This radar under development by the Heavy Military Electronics Department of the General Electric Company since 1956 has been installed and is presently undergoing service testing and evaluation by the Air Force.

The FPS-24 reportedly incorporates many of the latest signal processing circuits and techniques. It is designed to detect strategic, supersonic aircraft at longer ranges and higher altitudes than present operational air defense radars, despite the presence of interference and enemy countermeasures.

The AN/FPS-24 was designed for the Air Force by General Electric in cooperation with the Air Research and Development Command's Rome Air Development Center, Griffiss Air Force Base, New York and has won General Electric a $24 million production contract for an undisclosed additional number of FPS-24 radars. When placed in operational use, it will supply radar information to the SAGE Continental Air Defense System. There is much to know and learn about the strategic and tactical importance of the FPS-24 radar. Security restrictions to date preclude complete information. However, it is refreshing to know that our alert defense forces are not basking in the sunshine of past glories or preoccupying themselves in complacency with outmoded detection systems.

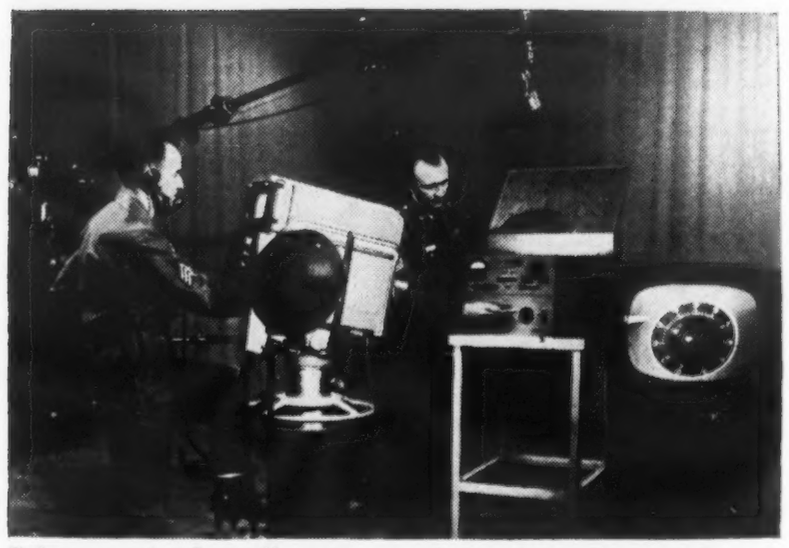
The FPS-24 antenna system, including reflector, pedestal and feed-horn weighs more than 135 tons. The reflector, which focuses the high power radar frequency pulses transmitted by the FPS-24 measures 120 feet wide by 36 feet high and weighs 30 tons. Made up in 34 sections, the reflector and supporting backup structure contains more than 12,600 feet of high strength aluminum and low temperature steel. The electronic equipment is housed in a total of 66 cabinets. Accuracy of the FPS-24 radar was not disclosed by GE.

The AN/FPS-24 Search Radar appears to be another worthwhile development on the part of American industry in its efforts to contribute to our national defense program.

TV

is military teacher at army's southeastern signal school

by BRIG. GEN. DAVID P. GIBBS
Commandant
U.S. Army Southeastern Signal School
Fort Gordon, Ga.



Enlargement of small parts on electronic equipment is one of educational TV's main advantages. Here tiny dial is shown at far right on TV screen for whole class to see.

TELEVISION — look at that word again. What do you see in it? The images flash through your mind faster than you could jot them down: entertainment—news—modern miracle—convenient—American genius.

Nearly all these words apply to that one-eyed box of yours. Since the "electron gun" led to development of the first TV set 20 years ago, television has become important to virtually every American.

Yet the Army Signal Corps is making some of its most noticeable progress in a field not ordinarily associated with cowboys and comedians—closed-circuit. educational television.

The Southeastern Signal School at Fort Gordon. Ga.. has been teaching Signal students via TV since 1952. Its success in educational TV has caused military and civilian educators throughout the nation to sit up and take notice. Since its inception here. educational television seems to have spread its own gospel. Groups of service and civilian educators have streamed into the studios here to study technical and educational methods. Among those who visited the Southeastern Signal School's television facility are crews from Redstone Arsenal. Ala.; Ft. Benning. Ga.; Lowry AFB. Colo.; Ft. Knox. Ky.; Ft. Bliss. Tex.; Ft. Eustis. Va., and Ft. Monmouth. N. J. Following their orientation. several of these installations opened their own television operations. Others plan to do so.

Original experiments were so successful that in 1957 the school expanded its TV studios into one of the best equipped educational-TV operations in the country. Today the school's TV studios have a 13-camera. five-channel operation — more channels than serve Kansas City. Mo.. or Atlanta. Ga. The studios use 78.000 feet of overhead transmission cable to pipe almost 200 programs a week to TV sets in 150 classrooms. To carry out an operation such as this. the studios use enough equipment and personnel to rival the country's leading television networks.

Southeastern Signal School students give educational TV the acid test, for through the picture tube they must learn the intricate workings of complex electronic equipment. The TV camera makes televised instruction of such equipment not only possible, but preferable.

Television in its present stage is not the ultimate in teaching. nor can it replace the individual instructor. Still, it has distinct advantages for both military and civilian schools. For instance. television can help solve the teacher shortage by taking over part of the teacher's job. Most courses—be they military or civilian —require basic lectures that could easily be "canned" and televised while the teacher carries out other duties.

The kinescope process allows a school to maintain a standard of teaching excellence. One of the top military instructors at the Southeastern Signal School was recently transferred overseas. Just a few years ago. that teacher's ability would have gone overseas with him. But the TV studios caught his recurring lectures on kinescope film and filed them for future classes. By the same token. any teacher could base his entire course on a series of kinescoped lectures.

Television does away with the need for a film projectionist in the classroom. By merely turning on the class TV set at a prescribed time, the instructor can have a filmed or locally prepared program to support his lecture. These programs can be duplicated and exchanged freely among schools.

In general. educational TV is effective both as a basic teaching medium and as a support for conventional teaching in the classroom.

The Southeastern Signal School's administrators have found that some students learn more via television while others learn more from actual classroom instruction. Some instructors do a wonderful job in the classroom but cannot adapt themselves to TV. Some subjects can be easily adapted to television while a limited number can be taught more effectively in the classroom.

Our most impressive lesson has been this: if a lecture isn't correct to the most minute detail. don't televise it. Students expect more from TV than from a classroom instructor. Most students accept televised instruction readily, but they react markedly to the program's quality and accuracy, and seem to sense if a subject is suited to TV.

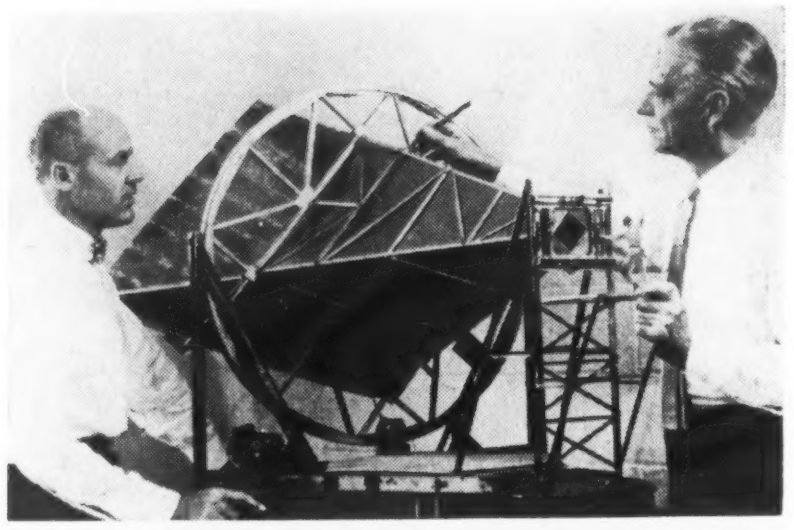
A televised lecture demands simple language, direct approach, clarity and well-organized material. Accuracy—even in the smallest detail—becomes absolutely necessary. Subject matter, program development and production quality affect the student directly. Even such minor points as classroom lighting, ventilation and temperature are important. Indifferent classroom performances usually accepted without comment by students would never meet their rigid demands on TV.

The Southeastern Signal School's instructors and administrators were skeptical of educational TV back in 1952. Now, almost to the man, they have faith in it. This faith is based on seven years of day-to-day experience.

Our national defense demands the world's best-trained soldiers. Someday it may demand them overnight. Educational TV could help produce them. It has been tested stringently for military education purposes—and, so far. it has passed.

TELEPHONE TERMINAL TO OUTER SPACE

Signal Staff Report



Engineers examine a model of the large horn antenna which will be used at the Bell Telephone Laboratories ground station for experimental communication via man-made satellites.

AN EXPERIMENTAL GROUND STATION for sending and receiving telephone messages by way of man-made satellites is taking shape on a hilltop in Holmdel, New Jersey.

The station, under construction by the Bell Telephone Laboratories on Crawford Hill, could point the way to a network of terminals for sending phone calls and live television to distant parts of the world. These stations would bounce radio signals off dozens of "sky-mirror" satellites.

The station will include control buildings and two large antennas for communication experiments with objects in outer space. One of the uses of the installation will be to take part in communication projects sponsored by the National Aeronautics and Space Administration (NASA).

One of the projects at Holmdel will test the quality of radio signals transmitted between stations on opposite sides of the United States by means of reflections from a satellite. Although single telephone channels will be used in the experiment, the objective is to determine whether television's "broadband signals" (the equivalent of about 900 telephone channels) could also be transmitted.

Such broadband signals cannot now be carried over present submarine cables, and cannot be transmitted directly by radio between widely separated points because the signals are blocked by the earth's curvature.

The microwave radio signals to be used in the experiment will be analyzed to obtain information about transmission effects. The data also will be studied to discover the reflection characteristics of satellites in orbit.

The satellite experiments probably will be preceded by test transmissions of signals using the moon as the reflector. The signals will be received and transmitted between NASA's Jet Propulsion Laboratory tracking station at Goldstone, Calif., and Bell Laboratories, some 2300 mile apart.

Heart of these communication experiments will be the antennas and the transmission techniques. The Holmdel installation will include a dish-shaped commercially available antenna to transmit signals, and a horn-shaped antenna will be the receiver. The latter antenna was designed by Holmdel engineers and is a large version, adapted for tracking, of the horn-reflector antenna which was originated some years ago at Holmdel for radio relay use in the Bell System.

The horn-reflector design permits the antenna to receive radio energy from essentially one direction, and less than one-millionth as much from other directions. The result is greater concentration on the wanted signal and less pickup of noise from other directions, especially the radiation from the ground, than for conventional antennas.

In conjunction with the horn, a highly sensitive receiver is required. The receiver will utilize extremely low-noise amplifiers, either a pair of parametric amplifiers or masers, or a combination of one each. The central element of a parametric amplifier is a semi-conductor. Maser is an acronym for "microwave amplification by stimulated emission of radiation." The central element is a ruby crystal contained in a liquid helium "refrigerator" at a temperature approaching absolute zero—about 460 degrees below zero (F.).

One of the initial and crucial problems in these experiments will be tracking speeding satellites precisely, and for this purpose Bell Laboratories will devise its own special equipment. Data predicting the passes of satellites will arrive in coded form and the new equipment will rapidly convert the information into a form suitable for controlling the antennas.

PROJECT ECHO

NASA TO LAUNCH 100-FOOT SPHERE

Signal Staff Report

THE NATIONAL AERONAUTICS AND Space Administration plans to launch a 100-foot-diameter inflatable sphere into orbit as a communications experiment early this spring.

Project Echo calls for the launch of an aluminum-coated sphere into a 1000-mile-altitude earth orbit. The launch is to be in a northeasterly direction from Atlantic Missile Range with an inclination of about 50 degrees to the equator.

The objective of the experiment is to test the feasibility of a passive reflector communications system on a global basis. The vapor-deposited aluminum skin of the big satellite will give it a high degree of radio wave reflectivity. After the 100-foot sphere is placed into orbit, NASA hopes to establish two-way radio communica-

tions between the East and West Coasts of the United States by bouncing signals off the sphere.

Once in orbit, the satellite will pass over all countries located between 50 degrees north latitude and 50 degrees south latitude. Its orbital period will be about 120 minutes. It is expected to pass over every portion of the United States except Alaska, enabling many independent researchers in the communications field to make use of the large sphere for propagation experiments. The maximum time of mutual visibility between the East and West Coasts for any one pass will be about 16 minutes.

The launch this spring will be the first of three Project Echo satellites. Each will be a 100-foot reflecting sphere developed at NASA's Langley Research Center, Virginia. The satellite will be an inflatable structure of .0005-inch-thick Mylar plastic coated with vapor-deposited aluminum to provide radio wave reflectivity of at least 98 percent up to frequencies of 4,000 megacycles per second. The sphere will weigh about 150 pounds. It will be as bright as a zero magnitude star—about as bright as Vega.

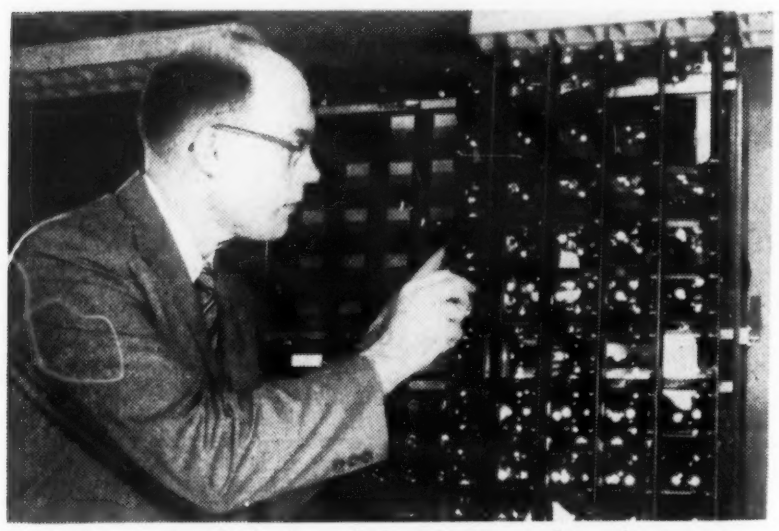
The payload package will be carried into orbit by a Delta launch vehicle.

At launch, the sphere is folded inside a 28-inch diameter container. About four pounds of water in a plastic bag is carried inside the sphere. At injection, the payload container opens by explosive bolts and the sphere begins inflation with the residual air inside the satellite. Inflation is completed as water in the plastic bag turns to vapor and expands.

The two major facilities involved in the experiment will be NASA/Jet Propulsion Laboratory's Goldstone Tracking station in California and a Bell Telephone Laboratory station at Holmdel, New Jersey.

Goldstone will transmit a 2390 mc/s signal for interception at Holmdel. The Bell antenna will transmit a 960 mc/s signal to be picked up by Goldstone.

Project Echo is NASA's first step in a long range investigation of the application of artificial earth satellites to global communications. Such satellites may one day be used as relay stations for transmission of signals, voice, and television.



M. B. Purvis, Bell Telephone Laboratories, makes adjustments on the optical system of the flying spot store, permanent memory for an experimental electronic telephone switching system.

PHOTO-OPTICAL MEMORY SYSTEM

Signal Staff Report

PHOTOGRAPHIC PLATES used in the permanent memory of an experimental electronic telephone switching system are now being exposed and developed automatically, according to Bell Telephone Laboratories. The permanent memory stores such things as directory information and instructions for the electronic switching system. This information is in the form of thousands of tiny clear dots on an otherwise opaque photographic area 2 inches square. Seventeen areas are used together to make up a complete photographic plate, and the entire permanent memory store is comprised of four such plates.

The spots of clear and opaque film are scanned by a beam which is generated by a cathode ray tube and focused by a system of lenses. This operation gives rise to the name of the unit—"Flying Spot Store." The movement of the beam is controlled by an electronic and optical positioning system which must be accurate enough to pick out a particular spot location on each area.

The flying spot store contains over two million bits of information as opaque or transparent spots, and can read out a 68 bit word (i.e., 68 spots simultaneously) every two and a half microseconds. Random access to any word adds a major feature of versatility.

The store itself is used to expose the plates. The moving beam from the cathode ray tube is focused through an objective lens onto the photosensitive area. The spot is moved over the entire two inch square image area and stopped briefly at positions where a spot exposure is desired. A photographic emulsion was selected which is "slow" enough not to be exposed by the passing of the beam alone, but requiring the lengthened exposure of the pause to make a record.

Each of the seventeen small areas on a plate is exposed individually, in sequence, while the others are covered by a system of shutters. Automatic control of this operation allows an entire plate, containing 550,000 spot positions, to be exposed in less than three minutes.

After exposure, the plates are withdrawn from the memory unit in a dust- and light-proof container and inserted into the automatic processor for developing and fixing. Two of the plates can be processed simultaneously.

Once the plates are inserted in the processor, they are automatically carried through a number of steps. They are dipped into one tank after another, depending on a predetermined schedule. As many as fifteen steps may be involved in a typical reversal processing schedule, and appropriate dwell times are also set to allow proper processing.

After developing, reversal and fixing operations have been completed, the plates are rinsed and dried in filtered air and delivered back into their container for reinsertion into the memory unit.

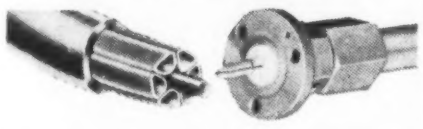
The time required for a complete developing schedule is less than a half-hour. Once the machine has been put in operation, it will continue through its sequence without interruption. The machine has been made simple to operate since it is expected that personnel unfamiliar with photographic procedures will operate it.

Prodelin - Prodelin EVERYWHERE...

It Makes You Stop and Think

Everywhere you turn, you see more and more Prodelin equipment being used for RF transmission. Coaxial cable, transmission line, connectors, antennas, and complete systems are all in heavy demand because of Prodelin's superior specs and performance . . . better price and delivery. Review your own needs and you'll see that Prodelin can do the job better for you!

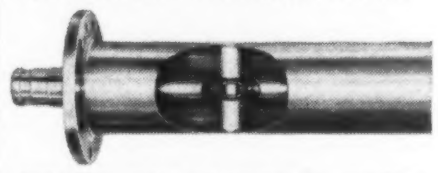
Prodelin Spir-O-line® Spir-O-lok®
SEMI-FLEXIBLE ALUMINUM COAXIAL CABLE & CONNECTORS



Whether your problem is weight, attenuation or power, Prodelin Spir-O-line does the job better. With Spir-O-line, you increase your system and aircraft range by reducing attenuation and weight. ½" Spir-O-line weighs only 12 lbs./100 ft. . . . handles 400 watts average power with a loss of only 4 DB/100 ft. at 2 KMC. ⅞" Spir-O-line weighs 34 lbs./100 ft. . . . handles 1 KW average power at 2 KMC. with a loss of only 2 DB/100 ft.

(PATENTS PENDING)

Prodelin Series 800
RIGID COAXIAL TRANSMISSION LINE



Ready to meet all demands, Prodelin rigid line is now available in Standard EIA copper, EIA lightweight aluminum and in aluminum with the new Spir-O-lok connectors. All lines feature the electrically transparent compensated pin supporting structure. This field proven feature allows peak powers which approach theoretrical values. The 3⅛" line can handle, at atmospheric pressures, peak powers of up to 3 megawatts with no additional pressurization.

New 4⅛" line can handle 50 KW average power at 250 MCS, for great savings through less weight and smaller line size.

Prodelin
MICROWAVE ANTENNAS

To complement its already famous line of microwave antennas, Prodelin makes available its unique antenna package for 6 and 7 KMC. The package incorporates Spir-O-line semi-flexible coaxial cable and Spir-O-lok connectors for low loss and easy installation. Available in 4, 6, 8 and 10 ft. antenna sizes the system is particularly recommended for use in passive reflector systems or on other short runs. The new system greatly reduces engineering time and component expense.

Prodelin
2-WAY MOBILE ANTENNAS

Prodelin's new series of VHF antennas include the ground plane, the unity gain coax, and the Omni-6. The Omni-6 is a collinear gain antenna designed to meet the need for a 6 DB gain antenna with a minimum of cost and wind loading. All antennas are corrosion resistant and terminate in type "N" connectors. All are capable of withstanding 100 MPH winds while giving superior performance. All connectors are protected by a metallic shield from installation damage and weather.

Send today for full performance data and specifications on the Prodelin line.

Prodelin stocks component parts, supporting hardware, and accessories for all lines.

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Letters to the Editor

Dear Sir:

Thank you for the copy of the May Convention issue of SIGNAL Magazine containing my article, "Photography Rediscovered." I think the format used in the magazine is excellent and the reproductions of the photographs are of the same high quality.

RAIFE TARKINGTON
Research Laboratories
Eastman Kodak Company

Rochester, N. Y.

Dear Sir:

I appreciate your action in publishing my article ("The Navy and Amateur Radio," June 1959 issue) because it seems to have conveyed the correct impression to the amateurs, i.e., we recognize and appreciate what they have done.

RAdm. FRANK VIRDEN, USN
ACNO (Communications)/Director,
Naval Communications

Washington. D. C.

Dear Sir:

Thank you for your courtesy in forwarding a copy of the June issue SIGNAL Magazine to me. I enjoyed it and I do hope that my comments ("Polaris—The Fleet Ballistic Missile Weapons System Program") will be accepted in the manner in which they were given, that is, to round out the question for need of major war deterrent systems and their place in the National scheme of things.

RAdm. W. F. RABORN, USN
Director, Special Projects
Department of the Navy

Washington. D. C.

Dear Sir:

Thank you for your letter of 4 September to which was attached a copy of the September issue of SIGNAL ("Budget Trouble [Even for NASA]"). The workings of government are difficult to understand at times—but I'm sure that frankness in dealings with the Congress and the public is a precious ingredient at any and all times.

T. KEITH GLENNAN
Administrator
National Aeronautics & Space Administration

Washington. D. C.

Dear Sir:

I certainly was pleased to see the fine treatment you gave Hazeltine's AN/TPS-25 ("A New Era in the Art of Combat Surveillance Through Industry-Military Cooperation," November 1959 issue). I have already received favorable comments.

R. L. BEAM
Executive Vice President
Hazeltine Electronics Division
Hazeltine Corporation

Little Neck, New York

Dear Sir:

I am pleased to have page 74 of the (December) Armed Forces Communications and Electronics Association publication SIGNAL.

This information should reach countless individuals in search of more information concerning the Patent System. Making this information available is certainly in the public interest.

ISAAC FLEISHMANN
Director
Office of Information Services
Patent Office
U. S. Department of Commerce

Washington, D. C.

AFCEA

1624 Eye Street, NW
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The President, the immediate Past President, the Vice Presidents and the Counsel are ex-officio members of the Board of Directors.
**Executive Committee Member.*

Association affairs

Executive Committee Meeting

At the opening of the Executive Committee meeting, January 14, President Benjamin H. Oliver, Jr., presented Frederick R. Furth a certificate for outstanding service performed during his two-year term of office as President of AFCEA.

Plans for the 14th National Convention were discussed. The following Convention theme was approved: "Communications and Electronics—The Arm of Control, The Voice of Command."

Other items included a report by General Manager W. J. Baird on AFCEA operations; chapter rebate program by Business Manager F. T. Ostenberg and a report on SIGNAL advertising by W. C. Copp, Advertising Representative.

Present for the first meeting of the Executive Committee in 1960 were Benjamin H. Oliver, Jr., Vice President-Upstate Territory, New York Telephone Co. and National President; Captain W. T. Dutton, USN, representing Rear Admiral Frank Virden, USN, Director, Naval Communications and First Vice President; Colonel James E. Morrison, USAF, representing Major General Harold W. Grant, Director of Communications-Electronics, USAF and Second Vice President; Lieutenant Colonel Kenneth E. Shiflet, USA, representing Major General R. T. Nelson, USA, Chief Signal Officer, and Third Vice President; W. Earl Trantham, Jr., Manager, Eastern Operations, Hughes Products, Hughes Aircraft Co. and Treasurer; Frederick R. Furth, Vice President, International Telephone and Telegraph Corp. and Immediate Past President; Glenn D. Montgomery, Defense Coordinator, Long Lines Dept., American Telephone & Telegraph Co. and Region A Vice President.

The following Directors attended the meeting: Joseph E. Heinrich, Staff Supervisor, Long Lines Dept., American Telephone & Telegraph Co.; Frank W. Wozencraft, Attorney-at-Law.

Representing National Headquarters were W. J. Baird, General Manager, Frank Ostenberg, Business Manager and Frank Martins.

New Group Member

Rixon Electronics, Inc., Silver Spring, Md., is a new group member of AFCEA. William Christopher, Washington, D. C., chapter president, presented the AFCEA group member certificate to a Rixon representative at the February 4 chapter meeting.

Company representatives are J. L. Hollis, president; C. J. Harrison, vice president; J. C. Myrick, director; R. E. Davis, assistant director; D. W. Perry, acting director-marketing; B. McKay, manager-engineering; G. Holland, senior support engineer; H. Paris, senior engineer; A. Gattfield, assistant director-engineering; R. A. Wainwright, consultant.

Regional Vice Presidents Meet

The first meeting of the regional vice presidents was held January 29 in Chicago at the Teletype Corp. offices. Walter H. Pagenkopf, Region E Vice President and Vice President of Teletype, acted as host for the group. Benjamin H. Oliver, Jr., National President and F. T. Ostenberg, Business Manager, attended.

Chapter Science Program

"Project Recruits for Sciences," the Santa Barbara chapter's program to encourage high school students to pursue a scientific career, was given a preview performance before the city's officials recently. (See January 1960, SIGNAL page 45 for complete details.)

Chaired by Clarence C. Ray, chapter president, the presentation was opened by Roger A. Moe of the Santa Barbara Research Center, who introduced speakers from military and industry. Maj. Robert Evans, assist. PMS&T, U. of Calif., S.B. and Robert Wilke of Raytheon Co. discussed the development of the "sniperscope" gun sight.

Edison Award Nominee

Ray Meyers, Region F Vice President, is one of the nominees for the Edison Amateur Radio Award, which will be presented February 25 to the U. S. ham who performed the most outstanding public service during 1959.

At National Headquarters

Rear Admiral Henry C. Bruton, Paris chapter president, visited AFCEA National Headquarters recently. Admiral Bruton is Director, Communications-Electronics, Joint Staff, Commander in Chief, U. S. European Command.

NEW MEMBERS

Listed below are new members of the AFCEA who have joined the Association during the month of December. Members are listed under the Chapter with which they are affiliated. The January listing will appear in the March issue.

Arizona

Maj. Donald K. Adams
Col. Francis N. Miller
1st Lt. Thomas E. Little, Jr.
Lt. Col. David M. Uhler

Atlanta

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C. Everett Jones, Jr.
Cecil G. Lively
William L. Anderson
Col. Charles A. Butter
O. Derwood Toler
Capt. William G. Parmenter
John T. Moore, Jr.

Augusta-Fort Gordon

M-Sgt. Wilfred R. Lines
Craig W. Goodwin
1st Lt. Cecil C. Geddings
Samuel Silverstein
Lt. Luther M. Stone
Capt. Felix S. Satey
M-Sgt. Gabriel S. Marge
1st Lt. Mortin Colby
M-Sgt. C. C. Betenbaugh
Sfc Gerald M. Foreman
Sfc Edward N. Kemper
Lt. Col. James E. Morris
S-Sgt. Singleton L. Johnson, Jr.
Maj. Erwin P. Reinecke
M-Sgt. Andrew J. Ward
Sgt. Richard V. Hall
Sfc Grant Hayes, Jr.
M-Sgt. Joseph G. Chapman
M-Sgt. Allen C. Byington
M-Sgt. Harvey H. Heath
M-Sgt. Clifford J. Herzberg
Clarence E. Weissenburger
1st Lt. Walter L. Greer
Raymond L. Gleason
M-Sgt. Harold A. Van Cammeyt

Baltimore

Col. Arthur L. Baker
Lt. Col. William D. Morgan

Boston

James D. Gordon
Ted P. Klamka
John A. Keenan, III

Chicago

John B. Denormandie
Jerome L. Deboo
John P. Hanan, Jr.
David E. Chapman
Capt. Robert H. Northwood

Dayton-Wright

Edward R. Thoms
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B. Linn Soule
Morton C. Benson

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John A. Stubblefield
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Thomas L. Sager
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Charles A. Gruber
Thomas R. Seman
Charles H. Word
Donald R. Wright
Wilbur J. Jahr
Dennis J. Lappen

Fort Monmouth

Pat S. Petrillo
Lt. Col. Leo W. Miller
Willis M. Patterson
Richard E. Francis, Jr.
2nd Lt. William R. Barnes
Russell J. Turner
Guilford Ennes
Capt. Percy W. Collom, Jr.

Frankfurt

Maj. Bernard C. Deloiser

Gulf Coast

1st Lt. Raynova B. Burck
Philip A. Sheets
1st Lt. Walter J. Harenski, Jr.
Robert D. Boden
M-Sgt. Freeland V. Andrews

Hawaii

Jerry J. Neville

Kansas City

James C. Neustadt
CWO Arthur W. Elkins
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C. Philip Johnson, Jr.

Lexington

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Ens. David J. Heilig

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Lt. Col. William J. Daly

Rome-Utica
William C. Dawson
William J. Morgan
Grady C. Holt
W. R. Burrows

San Diego
George A. McDaniel

San Francisco
Cdr. Herbert F. Knauer
William F. Main
James V. Vann

San Juan
Vicente A. Ramirez
Ernesto Viera

Santa Barbara
Ralph J. Terella
John A. Moseley
Arthur B. Clark
J. E. Lannan
LCdr. Ruel Whitcher
Frank Arguelles
Carl E. Avery
Robert C. McNeill
Edwin C. Hope
Charles E. Harty
John L. Fertig, Jr.
Joseph V. Kiehlbauch
Reuben H. Waldron
Dale M. Nevitt
Jack A. McRae
Wesley W. Holcomb
Baxter K. Wolf
Harry W. Kompanek
Herbert S. Woodward
Robert W. Daumiller

Scott-St. Louis
Maj. Miller J. Grimes
Lt. Col. Willis B. Lynch

Seattle
Maj. George V. Hamson
Lester C. Irwin
Capt. Donald F. Krick

South Carolina
Lt. Col. William E. Spaulding
Virgil C. Johnston

South Texas
CWO Martin E. Vandiver
Robert E. Williford

Southern California
Brig. Gen. Harrison Shaler
Fred W. Coble
W. Hunter
P. Anders
Eugene Lepore
P. A. Lepore

Syracuse
Cdr. Lawrence L. Smith
Brig. Gen. James K. Wilson, Jr.
William H. Seibert
Arthur N. Kaiser
Raymond F. Klippel
Paul B. Maxson
Richard McMahon
A. Noel Reagan
John S. Collinson
Arthur R. Grimm
Robert V. Neary
Paul L. Kingston
Edward T. Barry
John C. Hicks
John T. Robinson
Leslie C. Overlock
Clarence A. Nolph
Robert E. Davis
Urban H. Johnson
William Masin
Robert H. Rice

Tinker-Oklahoma City
Maj. James W. Witt
Capt. James R. Anderson
James E. Gallagher
Capt. Jackson Rayburn
Max W. Barker
Clohie C. Cross
Bill B. Walker
Capt. Charles N. Grice
Bryan K. Gamble
James R. White
Arthur R. Weber
Carl W. Eastman
William J. Cook
George Billy

Washington
Capt. Richard F. Rea
St. Clair Bromfield, Jr.
Graham Holland
Richard A. Wainwright
Allen Gattfield
Henry Paris
Bruce McKay
R. E. Davis
J. C. Myrick
C. J. Harrison
J. L. Hollis
Dean W. Perry
William O. P. Snead
Edward F. Walsh
W. Wall
Gordon F. Bogora

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John E. McCutchan, Evansville, Indiana
Charles E. Bates, Minneapolis. Minnesota
John J. Stankowsky, Minneapolis, Minnesota
Capt. NGO-Van-Dzoanh, KBC 4784, South Vietnam
1st Lt. Pham-Thong, KBC 4784, South Vietnam
ETC Joseph J. Collins, Navy 116, FPO, San Francisco. Calif.
Maj. Joseph D. Koger, Westover AFB, Mass.
G. R. Kilmer, Binghamton. New York

Association Affairs

(*Continued from page 47*)

ITU Officer

Captain Gerald C. Gross, USNR, Swiss chapter president, has been elected Secretary-General of the International Telecommunications Union in Geneva.

A former official of the Federal Communications Commission, Captain Gross had been serving as Acting Secretary-General of the ITU since June 1958. Before this time, he was Assistant Secretary-General of the ITU for eleven years.

Chicago Chapter

AFCEA National President Benjamin H. Oliver, Jr., and AFCEA General Manager W. J. Baird were the honored guests at the Chicago chapter's January 28 dinner meeting at Teletype Corp., Skokie, Ill.

Speaker for the evening was Louis L. Davis, Chief of the High Speed Unit of the Communications Systems Branch of the Federal Aviation Agency, who discussed "Weather Services of the Federal Aviation Agency." The talk concerned the scope of FAA services to military and commercial aviation. Mr. Davis also described the Automatic Data Interchange System, an electronic switching system.

AFCEA Sustaining and Group Members

Communications—Electronics—Photography

Listed below are the firms who are sustaining and group members of the Armed Forces Communications and Electronics Association. By their membership they indicate their readiness for their share in industry's part in national security. Each firm nominates several of its key employees or officials for individual membership in AFCEA, thus forming a group of the highest trained men in the electronics and photographic fields, available for advice and assistance to the armed services on research, development, manufacturing, procurement, and operation.

Sustaining Members

Cook Electric Co.
International Telephone & Telegraph Corp.
New York Telephone Co.

Group Members

Acme-Danneman Co., Inc.
Adler Electronics, Inc.
Admiral Corp.
Allied Control Co., Inc.
Allied Radio Corp.
American Cable & Radio Corp.
American Institute of Electrical Engineers
American Machine & Foundry Co.
American Radio Relay League
American Telephone & Telegraph Co.
American Telephone & Telegraph Co., Long Lines Dept.
Amphenol/Borg Electronics Corp.
Anaconda Wire & Cable Co.
Andrew Corp.
Arnold Engineering Co.
Atlas Film Corp.
Atlas Precision Products Co.
Automatic Electric Co.
Automatic Electric Sales Corp.
Automatic Telephone & Electric Co., Ltd.
Autonetics, Division of North American Aviation, Inc.
Barry Controls, Inc.
Beiser Aviation Corp.
Bell Telephone Company of Pa.
Bell Telephone Laboratories, Inc.
Bendix Radio Division, Bendix Aviation Corp.
Bliley Electric Co.
Bomac Laboratories, Inc.
British Thomson-Houston Co., Ltd.
Bruno-New York Industries Corp.
Budd Lewyt Electronics, Inc.
Burroughs Corp.
California Water & Telephone Co.
Cambridge Thermionic Corp.
Capitol Radio Engineering Institute, Inc.
Carolina Telephone & Telegraph Co.
Central Technical Institute
Chesapeake & Potomac Tel. Co.
Cincinnati & Suburban Bell Tel. Co.
Collins Radio Co.
Columbia Broadcasting System, Inc.
Contraves Italiana
Convair, Division of General Dynamics Corp.
William C. Copp & Associates
Copperweld Steel Co.
Cornell-Dubilier Electric Corp.
A. C. Cossor Ltd.
Craig Systems, Inc.
Crosley Division-Avco Corp.
Decca Navigator Co. Ltd.
Designers For Industry, Inc.
Diamond State Telephone Co.
Dictaphone Corp.
DuKane Corp.
Du Mont, Allen B., Laboratories, Inc.
Eastman Kodak Co.
Electronic Associates, Inc.
Electronic Communications, Inc.
Elgin Metalformers Corp.
Fairchild Camera & Instrument Corp.
General Analysis Corp.
General Aniline & Film Corp.
General Communication Co.
General Electric Co.
General Electric Co., Defense Systems Dept.
General Telephone & Electronics Corp.
Gilfillan Bros., Inc.
Globe Wireless, Ltd.
Gray Manufacturing Co.
Hallamore Electronics Co.
Hallicrafters Co., The
Haloid Xerox Inc.
Hazeltine Electronics Division, Hazeltine Corp.
Heinemann Electric Co.
Hoffman Laboratories, Inc.
William F. Hogan Associates, Inc.
Hughes Aircraft Co.
Illinois Bell Telephone Co.
Indiana Bell Telephone Co.
Indiana Steel & Wire Co.
Institute of Radio Engineers
Instruments for Industry, Inc.
International Business Machines
International Resistance Co.
Jacobsen Manufacturing Co.
Jansky & Bailey, Inc.
Jerrold Electronics Corp.
Kellogg Switchboard & Supply Co.
Kleinschmidt Laboratories, Inc.
Leich Sales Corp.
Lenkurt Electric Co.
Ling-Altec Electronics, Inc.
Litton Industries, Inc.
Lockheed Aircraft Corporation
Machlett Laboratories, Inc.
Magnavox Co.
Marconi's Wireless Telegraph Co. Ltd.
Materiel Telephonique Co.
McCoy Electronics Co.
Michigan Bell Telephone Co.
Montgomery Co., The
Motorola Inc.
Mountain States Telephone & Telegraph Co.
Mullard Ltd.
Muter Co., Rola & Jensen Divisions
National Co., Inc.
Nems-Clarke Co., Div. of Vitro Corp. of America
New England Tel. & Tel. Co.
New Jersey Bell Telephone Co.
North Electric Co.
Northwestern Bell Telephone Co.
Oak Manufacturing Co.
Ohio Bell Telephone Co.
O'Keefe & Merritt Co.
Pacific Mercury Television Mfg. Corp.
Pacific Telephone & Telegraph Co.
Packard-Bell Electronics Corp.
Page Communications Engineers, Inc.
Phelps Dodge Copper Products Corp.
Philco Corp.
Photographic Society of America
Plessey Co., Ltd.
Prodelin Inc.
Radiation, Inc.
Radio Corporation of America
Radio Corporation of America, Astro-Electronic Products Div.
Radio Corporation of America, Defense Electronic Products
RCA Great Britain, Ltd.
Radio Engineering Laboratories, Inc.
Radio Frequency Laboratories, Inc.
Ramo-Wooldridge, Division of Thompson Ramo Wooldridge Inc.
Raytheon Co.
Red Bank Division, Bendix Aviation Corp.
Reeves Instrument Corp.
Rixon Electronics, Inc.
Rocke International Corp.
Saxonburg Ceramics, Inc.
Scanner Corporation of America, Inc.
Servo Corporation of America
Singer Manufacturing Co., The Military Products Division
Smith-Corona Marchant Inc., Research and Development Division
Society of Motion Picture & Television Engineers
SoundScriber Corp., The
Southern Bell Telephone & Telegraph Co.
Southern New England Telephone Co.
Southwestern Bell Telephone Co.
Sperry Gyroscope Co., Division of Sperry Rand Corp.
Sprague Electric Co.
Stackpole Carbon Co.
Standard Electronics Co.
Standard Telephones & Cables, Ltd.
Stanford Research Institute
Stewart-Warner Corp.
Stromberg-Carlson Co., Division of General Dynamics Corp.
Surprenant Mfg. Co.
Sylvania Electric Products, Inc.
Technical Materiel Corp., The
Telectro Industries Corp.
Tele-Dynamics, Inc.
Telephonics Corp.
Teleprinter Corp.
Teletype Corp.
Texas Instruments Incorporated
Times Facsimile Corp.
T.M.C. (Canada) Ltd.
Trans-Sonics, Inc.
Tung-Sol Electric, Inc.
Union Carbide Corp.
United Telephone Co.
United Transformer Co.
Varian Associates
Webcor, Inc., Government Division
West Coast Telephone Co.
Western Electric Co., Inc.
Western Union Telegraph Co.
Westinghouse Electric Corp.
Wheelock Signals, Inc.
Wilcox Electric Co., Inc.
Willard Storage Battery Div., Electric Storage Battery Co.
Wisconsin Telephone Co.
Wollensak Optical Co.
Zenith Radio Corp.

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Region C: W. K. Mosley, Southern Bell T&T Co., Hurt Bldg., Atlanta, Ga. ***Southeastern States along Atlantic and Gulf coasts—from North Carolina to Louisiana including Tennessee.***

Region D: Maj. Gen. Harry Reichelderfer, USA (Ret.), Southwest Research Institute, 8500 Culebra Rd., San Antonio, Tex. **New Mexico, Texas, Oklahoma, Arkansas.**

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KOREAN: Sec.—William L. Wardell, OEC, RD-CD, APO 301, S. F.

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Chapter News

Arizona

The chapter reports that Lt. Col. Carl Dietrich has resigned as president since he has been temporarily transferred from duty as USAEPG. Lt. Col. Lloyd Snapp, USAR (Ret.) has been selected as his successor.

Augusta-Fort Gordon

L. C. Phillips was chosen president of the chapter for 1960 in an election held at the November meeting at Buck Lodge. Mr. Phillips is the District Manager of the Bell Telephone Company in Augusta.

Also elected were: first vice president—Lt. Col. Fred J. Frank; second vice president—Lt. Cmdr. Francis A. Saxon; third vice president—Maj. George A. Dewey; secretary—Orien Niehuss; treasurer—George Norman.

Elected to the board of directors were: Otto Leckman, Carl Rodgers, Jack Young, Jewett Harris, Julian Dean, Col. Thomas Trainor, John Meyers, Lt. Col. H. C. Williams, Capt. Egbert Buckhout, Brig. Gen. David P. Gibbs, Commanding General Army Signal Training Center, and Col. Robert R. Creighton, Assistant Commandant U. S. Army Southeastern Signal Corps School, were named national committeemen.

The formal installation of officers took place on December 17 at the Fort Gordon Officers Club.

Lt. Col. Fred J. Frank, Chief of Signal Integrated Training Facility, presented outgoing President Creighton with a gold lapel pin, citing him for efforts in increasing membership in the chapter.

The chapter reports that 22 men of the Southeastern Signal School's Central Office Supervision Course have joined AFCEA. They are the Center's first assemblage of persons to register 100 per cent with the AFCEA. The men are all technical personnel and represent 282 years of communication experience.

Baltimore

The chapter's traditional Christmas Dinner Dance was held December 4 at Fort George G. Meade.

J. Walton Colvin, chapter president, addressed the group and paid tribute to the nation's scientists, engineers and communicators.

"We have reached that period of the year when we pay homage to great men who have contributed so much to our free world," he said. "It is only fitting that tonight we take several minutes to pay our respects to the communicators, scientists and engineers who have left us advancements that have made us the strongest nation in space. These, too, were and are great men."

Chicago

Lt. Col. Willis E. Groves, Chief of Science and Engineering, Army Combat Surveillance Agency, discussed the Army's rapid missile capability as opposed to the Army's slower developing target acquisition ability, at the November meeting.

The Agency is pushing research in hopes of being able to provide combat surveillance by 1970, Col. Groves stated. Meanwhile, the best equipment now available will be provided and the Agency is establishing what will be the best interim equipment for the years 1962 to 1963, he remarked. (See page 49 for an account of the January meeting.)

Fort Monmouth

A Christmas party and dinner dance were presented December 17th by the chapter in the Sapphire Room of Gibbs Hall.

Gulf Coast

The December meeting was held at the Airmans Club, Kessler Air Force Base, Miss., and attended by 104 members and guests. A proposed slate of officers for 1960 was presented by Major Cecil Miller, Chairman of the nominating committee.

Mr. W. K. Mosley, Regional Vice-President of AFCEA and Assistant Vice President of Southern Bell Telephone Co., gave an historical account of progress in communications from the time of the "flat-footed runners of Rome and Greece" to the present electronics systems of today. Throughout his review of progress, Mr. Mosley pointed out the fact that the military had turned to the laboratory and to industry for aid in developing and producing new weapons systems. He emphasized that we have never "faced a time like the present" in which our struggle against new enemies has brought the science of modern warfare into "shocking proportions."

In closing, Mr. Mosley reviewed the family tree of AFCEA, tracing its development from its beginnings at the close of the Civil War to the present.

Kansas City

The chapter met December 3 at the Richards Gebaur Air Force Base Officers Club.

Mr. William Barnes, Demonstration Engineer of Southwestern Bell Telephone Co. was guest speaker for the evening. He discussed the various kinds of electronic equipment that have been developed by the Bell Laboratories in connection with the national space program and displayed models of the Vanguard and other equipment used in defense projects.

New York

The chapter held a dinner-dance December 16 at the Naval Shipyard in Brooklyn.

Paris

The Paris Chapter met December 8 at the Jardin de Montmarte for a dinner meeting and program. The subject of the program was the new Color Television System in France. Mr. Henri de France of Compagnie Francaise De Television made the presentation. Mr. de France originated the HDF system which bears his name. A premiere of this color TV system was featured at the meeting.

Philadelphia

The chapter met on January 28 at the Philadelphia Quartermaster Depot. Guest speaker was Brigadier General Elmer L. Littell, Commander, US Army Signal Supply Agency. His subject was, "Industry's Future with the U. S. Army Signal Corps." A film, "This is United States Army Signal Supply Agency," was presented and the chapter heard a panel discussion on, "United State Army Signal Supply Agency Activities." The chapter installed the newly elected officers.

The chapter made a tour of exhibits on communications and electronics equipment on display at the Depot.

Rocky Mountain

The chapter held a dinner meeting on the evening of December 10 at the Antlers Hotel in Colorado Springs. Honored guests were Mr. and Mrs. Richard Marsch who plan to move to Seattle.

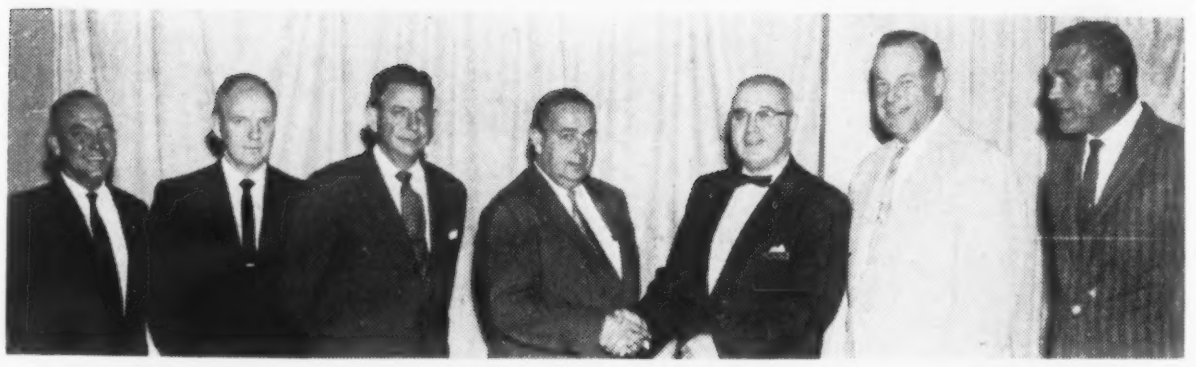
Several short films were shown at the meeting—*In Your Defense*, a new film on SAGE and *Operation William Tell*, a report on the world-wide Weapons Meet at Tyndall Air Force Base. A third film was a short preview of the February program which will consist of a talk and a showing of foreign commercial films which received high honors in competition.

San Juan

Representatives from International Telephone & Telegraph Corp. addressed the November 19th meeting held at the Officers Club, Fort Brooke.

RAdm. Richard H. Cruzen, USN,

(*Continued on page* 54)



Arizona—Shown at the November meeting are L to R: Lt. Col. W. Coeyman, Deputy Director of Orientation & Training, Ft. Huachuca; J. Kelly, sec.-treas. of chapter; Col. C. Burch, Chief of Staff, USAEPG; Comdr. S. Freedman, USNR (Ret.), guest speaker from San Diego; Lt. Col. C. Dietrich, and Deputy Chief, Meteorology Depart.; Col. A. Morley, Director of Orientation & Training; and Lt. Col. L. Snapp, USAR (Ret.), newly selected president of the chapter.

Augusta-Ft. Gordon—Col. Robert Creighton, Assistant Commandant, Southeastern Signal School, presents the gavel to Col. Fred Frank, Chief of SITFAC, during installation ceremonies of the chapter. Shown L to R: E. Norman, treas.; Brig. Gen. D. Gibbs, CG, Army Signal Training Center; Col. Frank, pres.; Col. Creighton; and O. Niehuss.

San Francisco—Pictured during a tour of the IBM plant are, standing L to R: J. Chatterton, Pres.; H. Kahrmann, Jr., program chairman; Col. H. Schnoor, USAR, v.p.; Miss Helen Green, IBM Hostess; C. Steffen, secretary; and Comdr. H. Anthony, USCG, a director.

Santa Barbara—At the head table of the Dec. meeting when chapter's program of Recruits for Science was presented are, L to R: R. Moe, treas.; R. Wilke, Raytheon Co.; Maj. R. Evans, USA, Assoc. PMS&T, U. of Cal., S.B.; Dr. Sayovitz, Dir. of Electronics, U. of Cal., S.B., and Dir., S.B. chapter; RAdm. C. Ray, USN (Ret.), pres.; Mayor Abbott of S.B.; Dr. Scharer, Supt. of Schools, S.B.; and Lt. Col. H. Dillard, USAR (Ret.), 1st v.p. Front table, L to R: T. Storke, former U.S. Senator and publisher of *S.B. News-Press;* Mrs. Storke; Adm. S. Murray, USN (Ret.), RAND Corp.; Mrs. Ray; G. Humphry, Raytheon.

Scott-St. Louis—Shown at the Eighth Anniversary meeting of the chapter are, standing L to R: W. H. Pagenkopf, Regional Vice Pres.; Benjamin H. Oliver, Jr., President of AFCEA; Col. G. A. Zahn, chapter pres.; and A. L. Eisenmayer, chapter secretary.

Cosmic Ray Intensity . . . . . .

Gravitational Force . . . . . .

Atmospheric Density . . . . . .

Outer Space Temperature . . . .

This important news comes from outer space via telemetry receivers designed and produced by Nems-Clarke. More than 95% of the telemetry receivers at United States missile test stations and ranges were designed and built by Nems-Clarke. Among many installations now using this equipment are:

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White Sands Missile Range
Eglin Air Force Base
Vandenberg Air Force Base
Army Ballistic Missile Agency

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(Ret.) Project Manager, ITT, explained the internal organization of ITT companies throughout the world and their connection with the parent company in New York. Don Morton, Manager, ITT Engineering & Construction Co. discussed the capabilities and activities of this organization and Don Stork, Head, ITT Customer Relations Dept., gave a short introductory speech on the general structure of ITT.

Santa Barbara

Working on its science program for high school students, the chapter recently held a demonstration meeting in which certain speakers discussed the program. (See page 47 for more information.)

Scott-St. Louis

Benjamin H. Oliver, Jr., AFCEA's National President and Vice President of New York Telephone Co., spoke at the chapter's December 4th dinner meeting held at Augustine's Restaurant, Belleville, Illinois.

Walter H. Pagenkopf, Region E Vice President, and Vice President of Teletype Corp., was a special guest.

Seattle

C. L. Wickstrom, Assistant Vice President, Pacific Telephone and Telegraph Co., presented a talk entitled, "Communication for Defense" at the chapter's November 18th dinner meeting held at the Four Winds Restaurant.

Using slides to illustrate his talk, Mr. Wickstrom explained the basic operation of such Air Defense components as radar centers, direction centers, control centers, intercept fighter bases and missile batteries, and outlined the mission of the Strategic Air Command.

A film depicting the preparedness of the Navy preceded the talk.

South Texas

Maj. Gen. E. DeCoursey, Director of the Southwest Foundation for Research and Education, discussed "The Effects of Ionizing Radiation on the Human Body" at the November 18th dinner meeting held at the Fort Sam Houston Officers Club.

Tinker-Oklahoma City

Held at Tinker Air Force Base Officers Mess, the second and third meetings of the chapter featured talks by representatives from Radio Corporation of America and Cook Electric Co., respectively.

Anthony Genetta, a design engineer from RCA, discussed RCA's latest work in the data computer field at the October 15th meeting. William Cook presented two films which covered Cook Electric's contribution to the defense effort in the general area of missile guidance and control systems at the November 19th meeting. One of the films covered the recovery of the first missile nose cone from outer space.

The 1960 AFCEA Convention, May 24, 25, 26, will feature the theme "Communications and Electronics—The Arm of Control, The Voice of Command." Booth space for this show has been sold out completely even with an added exhibit section. Advance reservations for social events are being accepted now at AFCEA National Headquarters, 1624 Eye St., N.W., Washington 6, D. C. Prices and dates for these are: May 24, Key-note Luncheon—$4.50. Evening Reception-Cocktails—$3.00 (no limit). Buffet Supper—$8.50; May 25, Evening Reception-Cocktails—$3.00 (no limit). Banquet—$12.50; May 26, Industrial Luncheon—$4.50.

Ballistic Missile Management

(*Continued from page 26*)

To feed information into this electronic data processing center requires fast, reliable, versatile communications to each of the squadrons, so that field transactions can be immediately and fully reported to the weapon storage site, so that Air Force stock from many commodity class depots are available at a single point to the contractor's storage site, at the factory—so that contractor peculiar items can be resupplied to the squadrons on a source-to-user basis, to maintenance and overhaul facilities, contractor and Air Force, so that items to be repaired or modified can be quickly returned to stockpiles.

Fast, reliable, versatile communications using transceivers to transmit the punch cards upon which all data is coded, and teletypes to send supplemental verbal instructions or to clear transceiver circuits for transmission; telephones for exceptional situations or stand-by emergency use—all these form the LogBalNet, directly linking the electronic data processing center with each and every using squadron as well as each element of the resupply and maintenance cycle.

All this results in greater operational readiness at the launching pad, with smaller stockpiles at the storage site, faster maintenance, quicker modification and overhaul period. It saves money and time by reducing procurement and inventories.

Speed and accuracy in getting all the facts to the electronic data processing center, taking action, communicating that action to the right place—these are cardinal steps in logistic support management.

But this action must be converted into hardware. The hardware must get to where it is needed. It goes through pipelines. With a pipeline in the sky, smaller stockpiles are needed at the storage site. The shorter the pipeline, the more efficient the weapon system.

In essence, electronic data processing keeps pipelines short by automatically setting up the best routing, packaging, and monitoring and expediting in-transit items.

Transportation scheduling is only one of the major processing runs which provide constant updated, correlated data on shipments and receipts. Other runs provide adjusted stock levels, items on order, in repair or in transit, current and precise item description, the exact items which make up each individual system, frequency and cause of failures by item, usage and attrition rates by item, the weapon system stock control, current financial status, and procurement and provisioning status.

A single complete set of logistics books using a common coded language, correlates each and every logistic support function through the electronic data process. It is indeed an indispensable tool of logistic support management but it does not eliminate the need for human judgment, human decision or human responsibility.

Missile Support and Management

It is my responsibility, as Logistic Support Manager, to carry out timely support and effective management for the Thor IRBM, and the Atlas and Titan ICBM's. My staff works with other Air Force managers, contractors, and missile squadrons, as well as provides policy on budget, procurement, transportation, maintenance, supply and liaison with using commands such as SAC and the Bomber Command of the Royal Air Force.

While electronic data processing takes care of all routine transactions, the system also recognizes problems it cannot solve—the exceptional situations. It calls attention to these problems by making a print-out on a high speed printer that is part of the data processing technique. These print-outs go directly to the manager who makes the decision and orders the exceptional action needed. This may be a print-out on a supply problem which, when decoded, tells him of the slower consumption rate of an item planned for in the initial provisioning. This is management by exception. It saves money by preventing overstocking of items, or assuring readiness by maintaining an adequate supply of spares.

Management by exception conserves executive talent by bringing to the manager only those problems that the machine has not been programmed to solve automatically.

A different example of management by exception is the data run which reveals a failure rate for a given item much higher than the programmed tolerance. The printout gives the causes of failure. The maintenance manager runs the item through tests and analyses. He may call maintenance people from the missile squadron, the contractor's technical representative, AMC maintenance specialists, and get an Air Force-Industry opinion. It may be determined, for instance, that the failure of the item is a design deficiency. Recommendations are made after engineers reevaluate the basic design. Such recommendations are then submitted to the Chief of Weapons Engineering for remedial action.

A surprisingly pleasant aspect of logistic support management at the San Bernardino Air Materiel Area is the kind and caliber of person attracted to the program. We have a very great need for additional people of selected talents who are now deficient in our organization. We need more imaginative systems and procedural types. Service engineers of the highest quality are needed at SBAMA. One specialty for which no classical description exists is the new specialty of the real property expert who must relate mundane structural equipment, utilities, etc., of our complex launch emplacements to the obvious, glamorous missile proper. This is a completely new field for the forward thinking young engineer.

Electronic data processing for ballistic missiles is neither a dramatic or dangerous mission when compared to other significant aspects of our Nation's defense effort. One might draw the inference that only the stolid, the colorless, the unimaginative personality would find a happy home in this somewhat sanitary environment. Happily, this isn't true.

Experts in personnel psychology state that two objectives must be met in order to get people to produce work efficiently. One is that management must generate a climate of success in which individuals can operate. The second is that the individual's craving to be needed must not only be recognized but satisfied.

Circumstance in part, and prior planning in part, caused establishment of the initial logistics missile organization for modern weapons at the San Bernardino Air Materiel Area. The organization is the pilot plant for advanced weapons, a prototype for logistic support of the future. The stimulation here is real, not artificial.

Our 1,600 employees meet real, innate challenges, requiring ingenuity and initiative on a daily, even hourly basis. They know they are not bound by precedent. There hasn't been a book to go by—they are authoring that book. So I should say that the climate is successful, and each individual in our logistics program knows intuitively that his daily contribution helps maintain operational reliability and operational readiness of the Royal Air Force's Bomber Command and our own Strategic Air Command in defense of the Free World.

But in conclusion, I hope that someday we can convert the tremendous assets of our ballistic missile logistics system to the resupply of space vehicles destined for manned, scientific exploration of the solar system.

NEWS ITEMS AND NEW PRODUCTS

The Spectrum of Conflict (1960-1970), is the central theme of Stanford Research Institute's latest quarterly *Journal*. The special issue is devoted to an examination of possible types of U.S.-Russian conflict during the next ten years.

The magazine features eleven articles dealing with various aspects of the Communist threat, and with possible United States strategies to insure not only our survival, but also dominance of free-world ideals.

In discussing the special issue, SRI *Journal* editor Charles A. Scarlott stated. "We decided on this subject because of a conviction at SRI, growing out of military and nonmilitary defense studies, that the full scope of the threat to survival of the free world needs to be better understood.

"The timeliness of this issue of the *Journal* is evident when one considers some of the issues raised by the authors. They include current national problems involving the following:

"1. Is a civil defense program a necessary part of our posture for resisting potential blackmail in the Nuclear ICBM era?

"2. What are the conditions of reaching a stable deterrent to a general nuclear war—or is it indeed a delicate balance of terror?

"3. Do we have the capacity both in economic resources and in national resolve—to meet the Soviet challenge in all phases of the spectrum of conflict and competition?"

Copies of this issue of the SRI *Journal* may be obtained at $1.00 each from Department C-109, Stanford Research Institute, Menlo Park, California.

• • •

An electronic generator with no moving parts has been designed to convert the heat of a rocket exhaust directly to electric power in order to run the steering controls of a rocket or guided missile.

The new device, a developmental RCA tube of the type known as a thermionic generator, has already produced up to 270 watts of power directly from a high-temperature heat source—an output of nearly 80 watts per pound of its 3½ pound total weight. Coupled to a Thiokol solid-fuel rocket motor in a special test mount, the tube has generated useful levels of power directly from the rocket exhaust heat during preliminary evaluation tests.

According to RCA and Thiokol engineers, the results of the tests with both simulated and actual rocket heat sources have shown the feasibility of using thermionic tubes as efficient and light-weight generators to produce the electric power required in larger missiles and satellite launching vehicles during the critical launching and upward flight stages. Such devices could power the steering mechanism of the rocket as well as the guidance, telemetering and related electronic equipment of a missile throughout the operating life of the rocket motor.

An RCA official explained that the experimental tube has the form of a hollow cylinder. In the Thiokol test facility, it slips like a sleeve over the rocket-flame tube through which the burning fuel passes. The device resembles conventional two-element electron tubes, or diodes, in having a cathode from which electrons are "boiled" by the application of heat, and another electrode to which these electrons flow to produce an electrical output.

In the experimental tube, the cathode is formed by the inner wall of the hollow cylinder, while the second electrode is formed by the outer wall. Between the two walls is a narrow space filled with cesium vapor. When the cathode wall is heated by the burning rocket fuel in the flame tube, electrons are "boiled" out of the cathode material and into the space between the two walls. The cesium vapor that occupies this space becomes ionized upon contact with the hot cathode and encourages the easy flow of electrons to the outer wall. The electrical power that is generated by this process is fed to the rocket steering control mechanism or to electronic apparatus by means of cables attached to the cathode and the second electrode.

The principles of the new tube were developed at RCA's David Sarnoff Research Center, Princeton, N. J., by Dr. Karl G. Hernqvist and a group of associates of the RCA Laboratories technical staff. The experimental device employing these principles in the tests was developed jointly by Dr. Hernqvist and F. H. Corregan, at RCA Laboratories and engineers of the RCA Electron Tube Divison under F. G. Blook, at Lancaster, Penna.

Dr. Hernqvist pointed out that the size and shape of the tube were designed specifically for the Thiokol test installation. The design of eventual operating types of thermionic generator tubes would vary in accordance with the various designs of the rockets in which they might be used.

• • •

A 20-page paper entitled *Roksonde, a Practical 200,000-foot Meteorological Sounding System*, is available from Cooper Development Corp. 2626 S. Peck Rd., Monrovia, Calif., a subsidiary of the Marquardt Corp.

Complete with graphs and dimensional drawings, the paper describes all system components, gives performance data and operational procedures and discusses variations of the basic system. The paper was prepared by Russell E. Loftman for the American Meteorological Society National Conference on Stratospheric Meteorology held in Minneapolis August 31 to September 3, 1959.

• • •

The Raytheon Company has developed a process for producing oriented graphite in commercial quantities. This material, called Pyrographite by Raytheon, is a high purity form of graphite, or carbon, which can withstand temperatures up to 6700° F, higher than any other elemental material.

Because of its highly oriented crystal structure, this material offers a unique combination of high temperature characteristics. Thermal and electrical conductivity is strongly anisotropic—that is, the material has higher heat and electrical conductivity in the plane parallel to the surface than in the plane at right angles to the surface. Other valuable properties are high density and impermeability to gases.

Oriented graphite has been produced in the laboratory for many years in minute quantities and its properties have long been investigated on a theoretical basis. By developing a process in which large quantities of the material can be produced, the material should find application in many fields where high temperatures have caused problems, such as in the missile and nuclear reactor areas. The Special Projects Office of the Navy's

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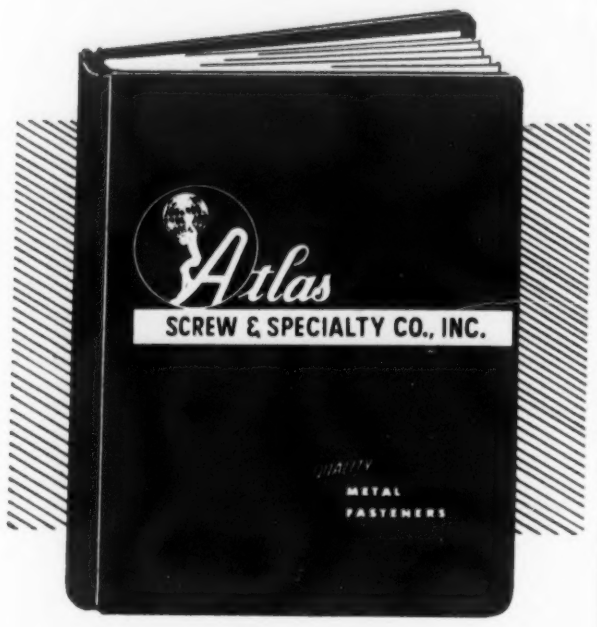

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Bureau of Ordnance is sponsoring developmental work at Raytheon on certain military applications of the material.

In the Raytheon process, the material is obtained from a carboniferous gas and deposited molecule by molecule on a substrate with controlled crystal orientation. Pieces composed entirely of Pyrographite can be produced by deposition on the inner surface of a graphite mandrel which is then cracked apart and separated from the workpiece.

• • •

The Marine Corps has announced plans for tactical evaluation of the new German developed anti-tank missile called the Cobra. The Corps has contracted with Daystrom, Incorporated, Murray Hill, N. J. for purchase of 100 of the wire-guided missiles. They will be manufactured in West Germany by Boelkow Entwicklungen K. G. of Munich, the company that developed the 810 weapon system, Cobra.

Tactical evaluation and test firing of the Cobra, which is already operational in the West German Army, will be accomplished by the 1st Anti-tank Battalion of the 1st Marine Division, Camp Pendleton, California under technical direction of the Marine Corps Landing Force Development Center, Quantico, Virginia. The test quantity of 100 missiles is scheduled for shipment to the U. S. early this year. Estimated cost of Cobra is $1,000 per missile. The cost of simulators and cathode ray tube is about $9,000.

The 810 weapon system Cobra consists of a guidance control box, a reel-cable, a terminal box or junction box, a field check-out set with battery charge and a field timing simulator. Capable of knocking out any tank in existence today, the man-transportable Cobra missile reportedly has a high kill probability at ranges between 500 and 1760 yards and can be fired at a rate of 1 every 45 seconds. The rocket burn out time is about 30 seconds. The missile weighs only 20 pounds, including a 5½ pound, shaped charge, high explosive warhead. It is 30 inches long, utilizes a solid rocket fuel, achieves a powered flight velocity of 190 mph and has a penetration capability of 21.5 inches on armor plate. The Cobra requires no special launcher. It is fired from ground emplacements and is controlled in flight with an electronic control box to which eight missiles can be connected for firing in sequence. By manipulating a stick on the control box, the gunner guides the missile to its target by means of electronic signals transmitted along a fine wire which spins out behind the missile in flight. Training time for an operator for efficiency is about 7 hours with training periods of 20 minute intervals after which the trainee is given an opportunity to fire 3 rounds on a field range.

Purpose of the Marine Corps evaluation is to determine the feasibility of adopting the Cobra to provide fast-moving ground combat units with a highly accurate, mobile helicopter-transportable defense against enemy armor in amphibious operations.

• • •

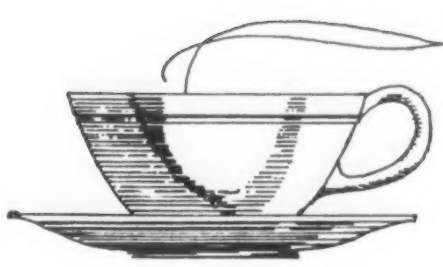
John Johnston, Jr., President of the Instrument Society of America (ISA), announced details of a major project of importance to every segment of instrumentation—the compilation and publication of specific information on thousands of transducers used in modern instrumentation. Working through the ISA Primary Elements Committee, a special Transducer Committee will assemble, classify, collate, edit and publish a comprehensive compendium of up-to-date information on all known transducers used in industry, medicine, biology and military applications. This program will embrace all transducers described in literature and those commercially available, both foreign and domestic.

Compilation and publication of the first volume is expected in January 1961. The first aspect of publishing the compilation is being financed by the Instrument Society of America. When the magnitude of subsequent operations has been clearly defined, support from appropriate granting agencies will be solicited.

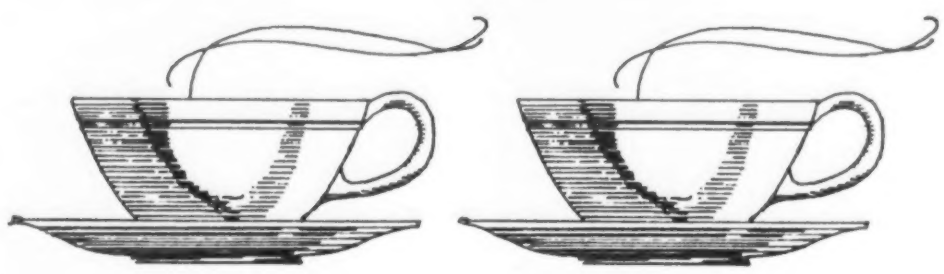
The project is under the direction of a distinguished committee of scientists and engineers long associated with instrumentation and transducer application. The Chairman is Dr. Carl Berkley, Research Associate, Rockefeller Institute, who will be responsible for photoelectric and optical transducers; Vice-Chairman is C. M. Bosworth, Instrumentation Engineer, Joseph E. Seagram & Sons, who is responsible for pneumatic and hydraulic transducers. Other committee members and their areas of responsibility are: W. A. Wildhack, Chief, and J. Stern, Physicist of the Office of the Basic Instrumentation of the National Bureau of Standards (general, coding, accelerometers); J. H. Heller, Director of the New England Institute for Medical Research (medical, biological); H. C. Roberts, Research Professor of

(*Continued on page* 60)

TAKE A COFFEE BREAK



...TAKE TWO!



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the University of Illinois (mechanical); J. E. Jacobs, Manager, Advanced Development of the General Electric Co., X-Ray Department (radiation); N. Serotta, Section Head Transducer Design, Raytheon Co. (ultrasonic) and Harold Berger, Physicist, Battelle Memorial Institute (optical).

The Committee is inviting both manufacturers and users of transducers to submit information and devices used or made by their organizations to the Transducer Committee, Instrument Society of America, 313 Sixth Avenue, Pittsburgh, Penn.

• • •

A nineteen year old Rutgers University student recently toured the U.S. Bases in the Antarctica as a guest of the Secretary of the Navy and the Commander of the U.S. Naval Support Force, Antarctica, Rear Admiral David M. Tyree. Jules Madey, an amateur radio operator from Clark, New Jersey, arrived aboard a Navy R7V Super Constellation, was welcomed by Admiral Tyree and invited to ride the four mile ice "highway" to the main base at McMurdo Sound by dog sled.

Jules' station, K2KGJ in Clark, is reported to have transmitted more than 12,000 messages and phone patches for Navy men in the past five years. During the Christmas season of 1958 he relayed orders for nearly $2,000 worth of flowers for DEEP FREEZE families. For new fathers, he has transmitted pictures of their offspring by amateur radio facsimile during the wintering-over period of DEEP FREEZE operations. Jules also inaugurated a ham-letter service by amateur radio teletype which provided mail service for wintering-over personnel during DEEP FREEZE IV, handling ham-letters up to 3600 words.

Jules started hamming with DEEP FREEZE since its inception and he keeps regular schedules with all the other U.S. Antarctic stations and with all the mobile construction battalion stations in the world. He is believed to have the strongest signal any amateur sends to the Antarctic.

In 1958 Jules, an electronics engineering student, won the General Electric Award for the "Ham of the Year" (the Edison Radio Amateur Award) for his contribution to the public service. Three years ago he won the Greater Newark Student Science Fair Grand Prize for inventing an ultrasonic drill.

• • •

The First Army MARS Technical Net has announced the appointment of 2 Associate Directors. J. P. Hoffman, Information Officer and Frederic H. Dickson, Chief of the Radio Propagation Agency of the U. S. Army Signal Corps at Ft. Monmouth will make arrangements for originating one speaker each month from among the Electronic Scientists and Engineers at Ft. Monmouth. The net can be heard each Wednesday evening at 9 PM EST on 4030 KC upper sideband.

The schedule for March includes:

March 2: "Transistorized Test Equipment for the Amateur Radio Station," by Robt. W. Gunderson, Editor, Braille Technical Press, N. Y.

March 9: "Fundamental Requirements for Military SSB Receiver Design," by Dudley Kahn, Instructor, Fixed Station Equipment, U. S. Army Sig. Corp School, Ft. Monmouth, N. J.

March 16: "Low Noise Preamplifiers," by Dr. James W. Meyer, Associate Director Division 4, MIT Lincoln Laboratory, Cambridge, Mass.

March 23: IRE Convention Recess

March 30: "Fundamentals of Single Sideband and Some Commercial Practices," by S. Edwin Piller, Group Supervisor, Eldico Electronics Div., Radio Engineering Laboratories, Inc., N. Y.

• • •

Stanford Research Institute mathematician Dr. Joel Brenner with assistance from Dr. Morris Weisfeld of SRI and Professor G. E. Latta of the Mathematics Department, Stanford University has developed a new theory which enables the prediction of slight variations in satellite orbits over long periods of time.

The theory has been borne out by mathematicians R. Fulton and N. Sherman of the University of California's Lawrence Radiation Laboratory in Livermore, California, who have made numerical calculations on a high-speed electronic computer confirming the results of the theoretical work.

Result of the study is a set of new complex mathematical equations which can be used to predict with greater accuracy the orbit that a satellite will follow for hundreds of revolutions under the influence of the Earth's gravitational field. Such long-term orbital predictions have not previously been practical for near-Earth satellites. Employing the new theory, Dr. Brenner and his colleagues have been able to calculate minor changes in orbit shape which were previously unknown. These suggest that observed variations in orbit shape need not be ascribed to differences in the Earth's gravitational pull between the Northern and Southern Hemispheres. Such variations are very similar to those which the new theory predicts for an Earth symmetrical about the equatorial plane when these variations are evaluated at suitably chosen intervals. In the Brenner-Fulton-Sherman study, it is shown that the amplitude and period of the observed variations are not inconsistent with a symmetrical Earth.

In noting orbital variations while observing the Vanguard II satellite last summer, scientists believed that these were caused by asymmetry in the gravitational pull of the Earth and had drawn the conclusion that the Earth was probably slightly pear-shaped.

Drs. Brenner, Fulton and Sherman believe that this conclusion can only be substantiated by much more voluminous observations. They point out certain internal inconsistencies in the data, and show that it is possible for the data processing program itself to introduce these inconsistencies. The present study shows that the orbit of the Vanguard II satellite is better interpreted as a standard orbit for a symmetrical Earth and that the conclusion that the Earth is noticeably pear-shaped is unwarranted.

The three California scientists have set forth the findings of their study in a paper, *Theory of the Determination of the Earth's Potential Field by Observations of Satellite Orbits.*

• • •

Teletype Corporation of Chicago has developed a punched-tape reader set which includes transmitter-distributor, motor, base and cover that is some 40% smaller in size and weight than previous models.

The new smaller tape reader, called the Model 28 Miniaturized LXD set, measures 5⅞ inches in height, 7½ inches in width and 9½ inches in depth and features facilities for sequential (serial) output, hundred-word-per-minute transmission and reduced power requirements. Optional contacts are available for multi-wire output. Models may be obtained to read 5 or 6 level chadless or fully perforated tape.

The set is proposed for a wide range of tape reading applications including on-line data transmission over existing communications facilities and off-line control of tape operated factory of office machines. Components of the set, such as the transmitter-distributor portion, are available separately (without motor, base or cover) for integration with systems equipment.

Teletype has applications brochures

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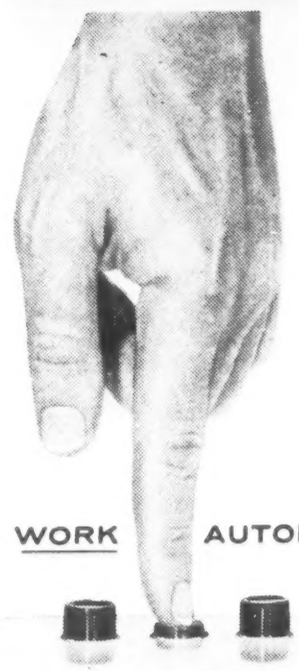
If you have a project in communications or control, AE can assist in the design, and supply the components or complete control packages. For quick results, write the Manager, Government Service Division, Automatic Electric Sales Corporation, Northlake, Ill.



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• • •

English abstracts of the following Russian technical journals are available by subscription from the Office of Technical Services, U. S. Department of Commerce, Washington, 25, D. C.

PB 141095T *Automation*, quarterly, 50¢ single issue, $2 for 4.

PB 141099T *Electrical Communications*, monthly, 60¢ single issue, $3.50 for 6.

PB 141105T *Radio Engineering*, monthly, 50¢ single issue, $3 for 6.

PB 141106T *Radio Engineering and Electronics*, monthly, 70¢ single issue, $4 for 6.

PB 141107T *Herald of the Electrical Industry*, monthly, 70¢ single issue, $4 for 6.

PB 141108T *Herald of Communications*, monthly, 60¢ single issue, $3.50 for 6.

PB 141109T *Journal of Abstracts, Electrical Engineering*, monthly, $1.40 single issue, $7.50 for 6.

A complete listing of some 100 abstracted Russian technical journals, *English Abstracts of Russian Technical Journals*, is available without charge from the Office of Technical Services.

• • •

The Chopper, sometimes referred to as a contact modulator, is the subject of a new technical series now complete through Part 6. The various Parts are titled, "Why Use Choppers?", "Definitions and Measurement", "Modulation Methods", "Applications and Performance", "Noise in Chopper Circuits" and "Chopper Amplifier Design".

Part 1 discusses why choppers are necessary and the types employed in the various applications. A glossary of chopper terms and mounting dimensions is included. In Part 2, detailed definitions and measurement of chopper parameters are provided and the test equipment used in measurement is discussed. Part 3 is devoted to modulation methods and practical modulator circuits. Analyses of capacity and transformer-coupled modulators, and of MBB and BBM transformer-coupled circuits are presented. Input circuits, phase relationship and the ambient changes are explored in Part 4. Part

5 describes noise sources, reduction of noise and comparative measurements. Part 6 details chopper amplifier design, frequency response in chopper amplifiers and chopper amplifier circuitry.

The series is being published by Airpax Electronics Incorp., Cambridge Division, Cambridge, Maryland.

• • •

The development of standard symbols for signalling systems, a plastic template and explanatory guide for the application of such symbols to architectural and other drawings has been announced by J. L. Taylor, who will represent the Signalling Apparatus Section on the Board of Directors of the Industrial Electronics and Communications Equipment Division of the National Electrical Manufacturers Association. Mr. Taylor is Executive Vice President of the Edwards Company Inc., one of 13 member companies of the NEMA Section.

In announcing completion of the two-year project, Section members said that the use of the approved national symbols for signalling systems on working drawings will "promote full understanding of the desired installation among designers, installers and suppliers of the equipment by giving each an opportunity to either indicate or determine in advance precisely what is required for a particular job."

Photoprogress

A way to make better color photographic enlargements electronically was described by Dwin R. Craig, vice-president and technical director of LogEtronics Inc., Alexandria, Va., before the Society of Photographic Scientists and Engineers annual conference in Chicago, Ill.

Craig described application of the LogEtronic enlarger to color photo reproduction, especially to printing from color negatives. The enlarger uses an electronic scanning light source in combination with a phototube that continuously modulates its brightness.

The phototube provides automatic dodging or print correction by dimming the light source in shadow areas and increasing its brightness in highlight areas, Craig said. With this method both detail and color can be preserved in the highlights and shadows of the resulting print, he explained.

Each of the primary colors, (red, yellow and blue), which determine the color balance of the final print, is measured on the enlarger printing easel. Controlling the relative exposure time of each of these primary colors gives proper color balance and print density, the scientist said.

Craig, who invented the LogEtronic principle, has worked extensively in the fields of electronic computation, nucleonics, radiography, optics and instrumentation. His application of electronics to provide automatic dodging and exposure control in photographic printing won for him the 1956 Fairchild Photogrammetric Award for outstanding achievement.

• • •

Latest information on movie cameras with built-in exposure meters can be found in the revised edition of a 24-page booklet put out by Eastman Kodak Co.

Better Movies In Color gives tips on both the outdoor and indoor uses of these movie cameras. The booklet also contains a table presenting exposure indexes and filter information for two types of Kodachrome Color Movie Film.

Names in the News

Maj. Gen. Frank W. Moorman became Signal Officer of Supreme Headquarters. Allied Powers in Europe February 1. Gen. Moorman replaces **Maj. Gen. Victor A. Conrad** who has been SHAPE Signal Officer since June 1957.

RAdm. Richard S. Mandelkorn, USN (Ret.) has joined General Instrument Corp. as executive vice president of its Harris Transducer Corp. subsidiary.

Maj. Gen. Albert F. Cassevant, CG at Ft. Monmouth, N. J., retired last month and will be succeeded by **Brig. Gen. William D. Hamlin**, Signal Officer, U. S. Army Europe.

Dr. Lloyd T. DeVore has been appointed director of engineering of the Laboratories Div., Hoffman Electronics Corp. Dr. DeVore also heads the Hoffman Science Center in Santa Barbara.

Robert M. Wopat, president of General Telephone Laboratories, Inc., since 1956 is now president of General Telephone Co., of Illinois. He succeeds **Burton W. Saunders** who is now chairman of the Illinois Company. **Frank D. Reese** is the new president of General Telephone Laboratories in Northlake, Ill.

Kenneth M. Lord has been appointed vice president and general manager of the Electronics Div. of Stromberg-Carlson, succeeding **George A. Peck**, who resigned. He was director of engineering in the company's Electronics Division.

Henri Busignies, former president of ITT Laboratories, has been named vice president and general technical director of the parent company. Busignies, who has been with ITT for 30 years, will coordinate ITT's global research and development activities.

Frank B. Jewett, Jr., succeeds **J. Carlton Ward** as president of Vitro Corp. of America. Mr. Jewett was vice president for chemical operations and an executive vice president of the company. Mr. Ward is now chairman of Vitro and succeeds **Charles S. Payson** who was elected to the new office of chairman of the executive committee.

John Robinson Binns, honorary chairman of the board of Hazeltine Corp., passed away December 8 at the age of 75. He had served as director, vice president, president and chairman of the board of Hazeltine. In 1957, he was elected first honorary chairman of the firm.

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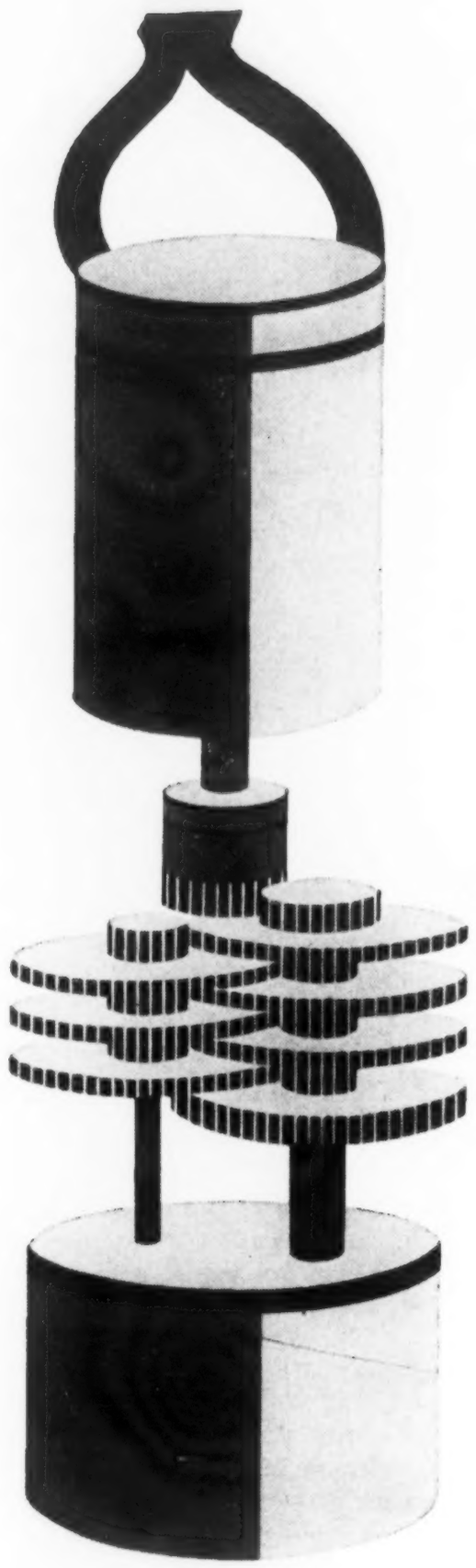

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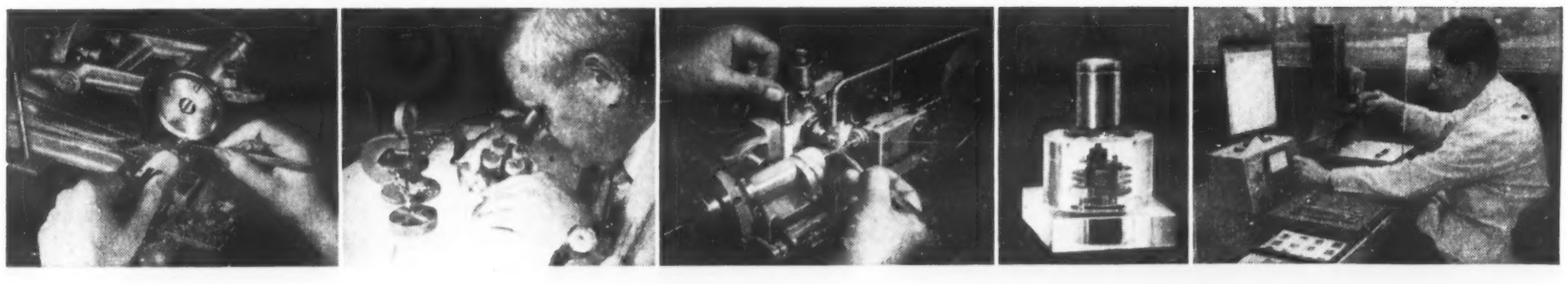

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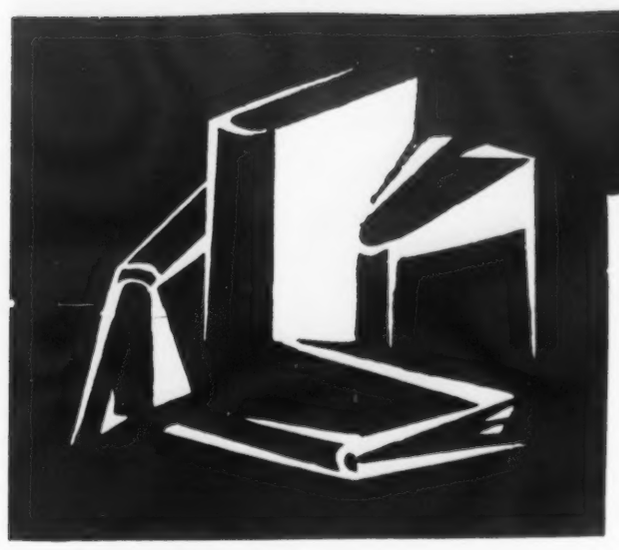

GENERALS IN GRAY, by Ezra J. Warner. Louisiana State University Press, Baton Rouge, 1959. 420 pages, $7.50.

Generals in Gray provides biographical sketches of all the generals in the Confederate Army.

The sketches give a concise outline of the careers of the generals with special attention to their war service, as well as the salient facts of their lives before and after the war, dates of birth and death and military ranks.

Based on ten years of research, this volume corrects many errors in the standard reference works and gives data which is available in no other published source. Besides the biographies which are accompanied by individual photographs, the book includes a summary of facts about the Southern military leaders. For example, 146 of the 425 generals were graduates of West Point, including all of the full generals and fourteen of the seventeen lieutenant generals. Of the full roster, 70 percent were in grade at the war's end, but nearly 19 percent of all generals were killed in action.

To the student of history, the many facts presented here provide an excellent insight into the Confederate command.

NONDESTRUCTIVE TESTING HANDBOOK, edited by Robert C. McMaster. The Ronald Press Co., N. Y., 1959. 2 volumes, $24.00.

This handbook, published under the auspices of the Society for Nondestructive Testing, integrates the experience acquired throughout industry to date in selecting, applying and interpreting tests designed to improve performance reliability of equipment in order to cut costs and reduce breakdowns and accidents.

Throughout, it synthesizes practical know-how and authoritative judgment in nondestructive tests applicable to all industries. Much of the data on test application and interpretation is made available for the first time, particularly in advanced fields such as penetrating radiation, magnetic-field, eddy current and ultrasonic testing.

The handbook is edited by Robert McMaster of The Ohio State University with a board of 106 contributing and consulting editors selected from this country and abroad.

INVENTIONS, PATENTS AND THEIR MANAGEMENT, by A. K. Berle and L. Sprague de Camp. D. Van Nostrand Co., Inc., N. J., 1959. 602 pages, $12.50.

This book tells how to develop an idea into an invention, a good patent, a good product and a return on your investment.

44 actual cases are presented which provide answers to questions concerning the task of making money with inventions.

The authors discuss principles and procedures that apply to working with patents in all fields of technology.

The theme of the book is that inventing is a business and he who would work and succeeed in this field must know its rules and conditions as in any other business. The inventor who knows the right procedures to follow and the mistakes to avoid saves himself much expense, grief and time.

NOMOGRAPHY, by Alexander S. Levens. John Wiley & Sons, Inc., N.Y., 1959. 296 pages, $8.50.

Nomograms, graphic presentations of numerical relations, were discussed by Professor Levens in the first edition of *Nomography* published in 1948. That edition won immediate acceptance for its accurate and clearly-defined presentation of the theory and construction of the alignment chart, a type of nomogram which has gained the most favor.

The new edition has been revised and expanded by 90% and provides a modern, up-to-date treatment of this mathematical tool. The book offers three completely new chapters on circular nomograms, projective transformations and the relationship between concurrency (Cartesian) and alignment nomograms with applications to experimental data. In addition, the author has expanded three chapters to include: methods for designing nomograms for four variables without the need of a turning axis: material on nomograms which consist of two curved scales and a straight line scale and three curved scales; and a more extensive treatment of the use of determinants.

The mathematical developments for the various type forms throughout the book have been simplified and many new problems and examples are introduced. The appendix contains 58 nomograms in such fields as: statistics, tests and measurements, various branches of engineering, physical and biological sciences, food technology, heat transfer, satellite launching and radioactivity.

The author, Alexander S. Levens, is Professor of Mechanical Engineering at the University of California at Berkeley.

ENCYCLOPEDIC DICTIONARY OF ELECTRONICS & NUCLEAR ENGINEERING, by Robert I. Sarbacher. Prentice-Hall, Inc., N. Y., 1959. 1417 pages, $35.00.

This new reference book was designed to be a central source for all standard definitions which have been approved by every official technical society. It sets forth in alphabetical order all the terms, equipment, elements, components and systems used in the scientific fields covered. There are 14,000 entries, 1,400 illustrations and 17,000 cross-references.

Dr. Sarbacher has presented this material in a thorough and comprehensive manner.

The book which represents several years of research is a real contribution to the fields of electronics and nuclear engineering.

Books of interest received too late for this month's review:

CHEMISTRY OF NUCLEAR POWER, by J. K. Dawson and G. Long. Philosophical Library, N. Y., 1959. 208 pages, $10.00.

An informative account of the vital part played by chemists in the nuclear power development program giving a broad view of established practice, present lines of thought and indication of problems for future effort.

The authors are engaged in research work at the Chemistry Division at Harwell, England.

NAVAL CUSTOMS, TRADITIONS, AND USAGE, by Leland P. Lovette, Vice Admiral, USN, Ret. Published by U. S. Naval Institute, Annapolis, Md., 1959. 358 pages, $5.50.

A fourth edition of the classic reference for the meaning of nautical words and expressions and the origin of naval customs and for access to information on military and naval etiquette.

Personnel & Positions Available

As a service to AFCEA members, SIGNAL will make space available in this column for those members who are interested in employment in the communications, electronics and photography industries. Any member is entitled to three insertions in the magazine on a space available basis, free of charge. Please limit your notice to 5 lines. In replying, employers are asked to address: Box ....., SIGNAL, 1624 Eye St., N.W., Washington 6, D. C. Letters will be forwarded to the AFCEA member.

COL. USAFR, TRIAL ATTORNEY before Armed Services Board of Contract Appeals desires legal or executive position with national corporation engaged in defense work; earlier 14 years general and corporate practice. Former Legal Advisor, Signal Corp. Midwestern Regional Office. Box 151.

WASHINGTON REPRESENTATIVE with several years experience handling both field and contractural problems. Familiar with research and development and production work in the communications-electronics field. Four years at present company. Box 152.

LIAISON REPRESENTATIVE FIRM desires to assist companies with Government business by acting as their Washington representative. Box 153.

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ELECTRICAL ENGINEER with 9 years' experience in all phases of telephone utility operation-engineering, accounting, traffic and management. B.S. in electrical engineering and business administration. Salary and location open. Box 155.

Industry Positions

This space will be available each month to Sustaining and Group Members of AFCEA who wish to state personnel needs. Persons interested should reply directly to company.

SENIOR SCIENTIST, SOLID STATE (119-402-186B): To perform advanced development work on magnetic amplifiers and in areas of solid state logic circuitry; M.S. in physics; Ph.D. desired; salary to $12,500. Indicate position number and submit resume to: Technical Personnel Dept., Stromberg-Carlson, Electronics Center, Rochester 3, N. Y.

TEST EQUIPMENT ENGINEER (039-335-061B): To design and build test jigs and fixtures for testing electronic and acoustical equipment; will prepare test procedures; 5 years' experience in design of test equipment or related instrumentation; B.S. in E.E.; salary to $9,500. Indicate position number and submit resume to: Technical Personnel Dept., Stromberg-Carlson Electronics Center, Rochester 3, N. Y.

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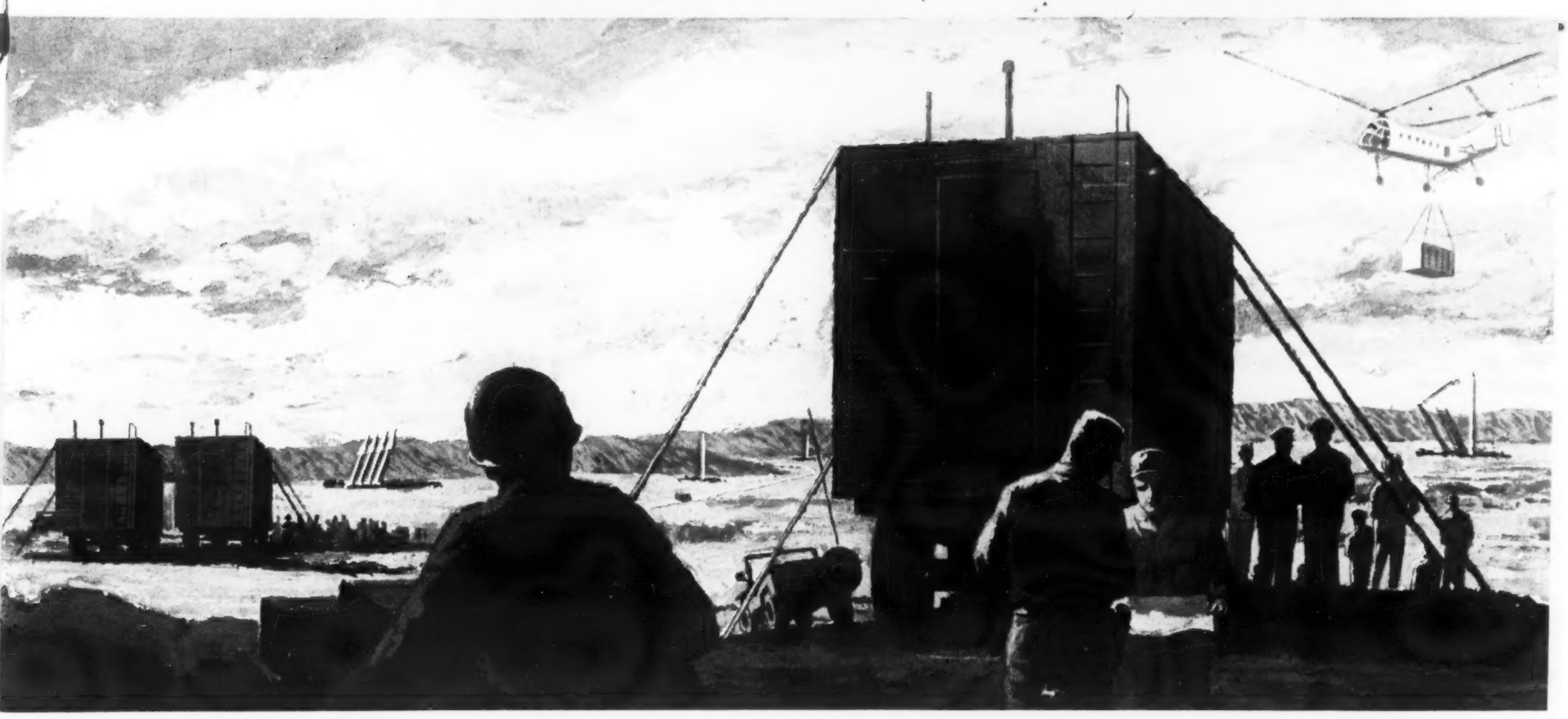

The recent demonstration of multi-purpose test equipment (MPTE), developed by RCA under a series of Army Ordnance contracts, highlights *a new dimension in automated multi-use systems support* and culminates a long-term RCA effort in this field. This General Evaluation Equipment is an automated, transistorized, dynamic checkout system. It contains a completely modularized array of electronic and mechanical evaluation equipment, capable of checking a variety of electromechanical devices, ranging from radar subassemblies to missile guidance computers. MPTE provides the stimuli, programming, control, measurement and test functions for the NIKE AJAX, NIKE HERCULES, LACROSSE, HAWK and CORPORAL missile systems and has been extended to other weapons systems related to our defense efforts.

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RADAR AND REVOLUTION

One sweltering July afternoon in 1789, a tattered raggedy mob appeared outside the gates of the Bastille, the formidable prison of Paris, and demanded entrance.

"Go away," the guard shouted, "or we'll have to arrest you."

"That's exactly the idea!" a voice came back. "We're starving to death. All we want is a little of that moldy bread and canal water you feed your prisoners!"

Word was passed to the prison commandant, one Maurice Antoinette. "If they want their just desserts," he smiled, "let them eat cake!"

It was this remark that sparked the Revolution. The mob grew ugly. "Force the gate!" shouted a sickle-wielding daughter of France named Brigitte Sourdough. A radar controlled battering ram, appropriated from the local armory, swung into play. In moments, the Bastille gate had been hammered into shambles, and the unfortunate Maurice Antoinette was at the mercy of the mob.

"Observe the instrument of your defeat!" sneered Brigitte Sourdough, pointing at the radar.

"Pfui," the commandant replied, calm and disdainful. "No Beaumac (French for Bomac) tubes."*

Brigitte was furious. "The commandant wants 'Beaumac'? He shall have Beaumac!"

With that, Antoinette was led to a second instrument of the people — a device consisting of a heavy blade, poised between grooved uprights. It had no tubes at all.

"This is your Beaumac?" the commandant asked.

"Oui, monsieur," Brigitte Sourdough leered. "This is Beau Mac — the knife!"

No sooner had Maurice Antoinette heard these words than his icy calm vanished.

Matter of fact, he lost his head completely.

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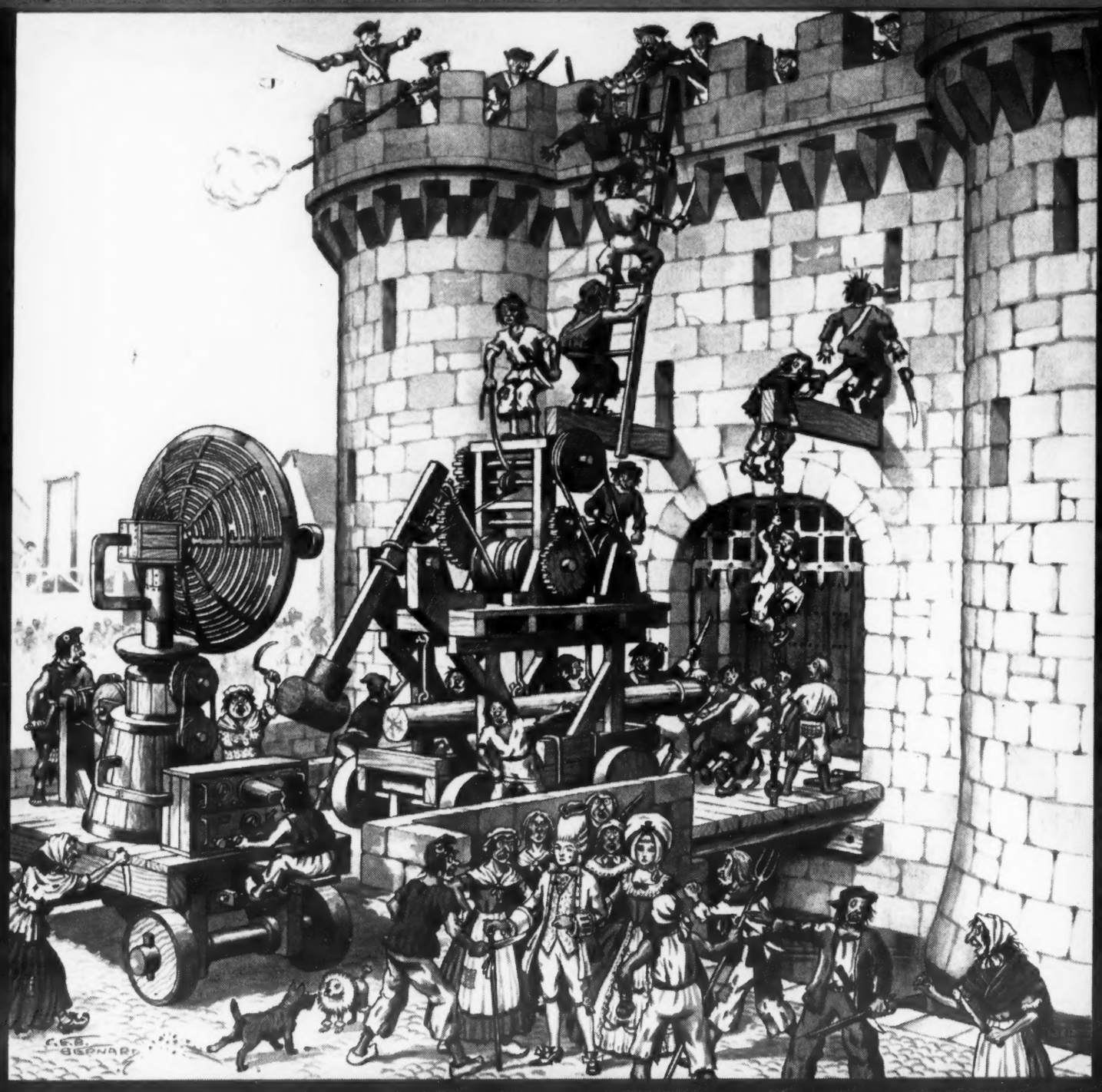

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